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BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
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(CRUSTACEA, COPEPODA: PARASITES OF FRESH-WATER FISH)

J. P. HARDING

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J. P. HARDING

Pp. 1–27; 95 Text-figures

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ON SOME SPECIES OF *LERNAEA* (CRUSTACEA, COPEPODA: PARASITES OF FRESHWATER FISH)

By J. P. HARDING

(*With ninety-five text-figures*)

SYNOPSIS

Twenty-eight species of *Lernaea* are recognized, of which fourteen are represented in the collections of the British Museum. Nine of these are new species. In addition there are seven names in the literature which are relegated to the synonymy. A key to the twenty-eight recognized species is given and the fourteen species in the Museum are described and figured.

ONE result of the renewed interest in the freshwater fisheries of Africa and other countries in recent years has been an accumulation of the parasites of these fish in the British Museum with requests for their identification. Attempts to name the species of *Lernaea* on the basis of existing descriptions and keys soon showed that a high proportion of them were new, and that Cunnington's (1914) and Wilson's (1917 & 1918) revisions and keys are out of date.

There is no need here to repeat recriminations against Wilson (1917) for transposing the names for the genera *Lernaea* and *Lernaeocera*. The inevitable confusion caused by this strict interpretation of the Rules of Nomenclature has fortunately been lessened by the fact that subsequent workers have, however unwillingly, nearly all agreed to follow.

As is often the case with degenerate parasitic forms, the characters used to distinguish between species are often ill-defined and not easily seen. Wilson often expressed the opinion that species of *Lernaea* and other parasitic copepods could readily be distinguished by reference to their appendages; but I have found extraordinarily little difference between the appendages of one species and those of another. The first four pairs of pereiopods, which will be referred to as legs 1 to 4 in this paper, are the only appendages that are easily examined as they are flat, and as each has a number of setae and spines I expected variations in their arrangements to provide useful characters for distinguishing species. Unfortunately I could find hardly any variations. The precise arrangement of the setae and spines was investigated in fourteen species, and in thirteen of them it was identical, only one of them could be separated on this basis. Table 1 gives the arrangement of the setae and spines in the thirteen species. *L. bistricornis* is included although I was able to see only legs 3 and 4; all four pairs of legs were seen in the other species. *L. haplocephala* differs from all these species in having four setae instead of five on the terminal segment of each exopod (Table 2, p. 19). *L. oryzophila*, according to Monod's (1932) description and figures, differs from the other species, having four instead of three spines on the last segment of the second exopod and two spines instead of three on the last segment of the fourth exopod. *L. dolabroides* (Wilson, 1918, figs. 77 and 78) seems to have a quite different setation of its legs.

Table 1

Arrangement of the setae and spines on the legs of *L. bagri*, *L. barbicola*, *L. barilii*, *L. barnimiana*, *L. bistricornis*, *L. cyprinacea*, *L. diceracephala*, *L. longa*, *L. lophiara*, *L. palatae*, *L. piscinae*, *L. tilapiae*, and *L. tuberosa*

		Leg 1	*Leg 2*	*Leg 3*	*Leg 4*
Exopod	spines	1.1.2	1.1.3	1.1.3	1.1.3
	setae	1.1.5	1.1.5	1.1.5	1.1.5
Endopod	spines	0.0.2	0.0.2	0.0.2	0.0.2
	setae	1.1.4	1.2.4	1.2.4	1.2.3

The other appendages are even less useful than the legs for separating one species of *Lernaea* from another. Wilson (1920, p. 7) claims that *L. haplocephala* may be distinguished by the 'small spherical terminal joint of the maxillipedes, with its four curved claws'. This may have been true of the specimen he examined, but I find that the maxillipedes of the type specimens of *L. haplocephala* have five claws like any other species and that the terminal segment does not appear to have any specific shape. Fig. 34 gives the arrangement of the mouth parts as far as I have been able to see these very minute appendages.

We are left with the shape of the body and with the internal anatomy for distinguishing species. Unfortunately it is difficult to study one without destroying, or at least distorting, the other, and I have neglected a study of the internal anatomy in favour of the shape of the body and its processes, and in particular that of the anchor. I am restricting the use of the word 'head' to that small, rounded part which bears the antennae and the mouth parts. The swollen part with processes which are usually described as 'cephalic processes', 'cephalic arms', or 'cephalic horns' I propose to call the anchor and its arms, as this describes both the appearance and the function of this part of the body. The anchor is often difficult to remove from the flesh of the fish without damage, and I have adopted the method of cutting out the part of the fish with the parasite embedded in it and placing it in a tube with a solution of potassium hydroxide to which a little chlorazol black has been added. If this is left for about twenty-four hours the tissues of the fish are usually softened sufficiently for the *Lernaea* easily to be removed; the chlorazol black stains the chitin of the parasite a dark blue. The external shape of the animal is well preserved by this method and the appendages can be examined without difficulty. The egg-sacs should be removed before placing the parasite in the hydroxide or they will be destroyed.

All drawings and measurements of specimens recorded in this paper have been made with the aid of a camera lucida. The total length of a specimen is understood to mean the length from the front of the head to the end of the abdomen, allowance being made for bends and curves in the body. Parts of the anchor which may project in front of the head and the furcal setae are not included in this measurement. The measurement and drawing of curved specimens was helped by the use of gimbals which enabled the specimen to be held in any position on the stage of the microscope. The gimbals, similar in principle to those of a ship's compass, but with sufficient friction in the bearings to prevent free swinging, were made of concentric cylinders of perspex, as shown in Fig. 1. The whole is submerged in formalin in a glass vessel and the specimen is placed in the central cylinder, which is closed at the bottom to form a dish.

I have found the shape of the anchor and its arms to provide the most useful characters for taxonomic purposes. In spite of the fact that the shape of the anchor is liable to be distorted by meeting bones and other hard obstructions during its growth in the body of the fish, each species has a characteristic form which varies within limits which are usually definable provided sufficient material is available.

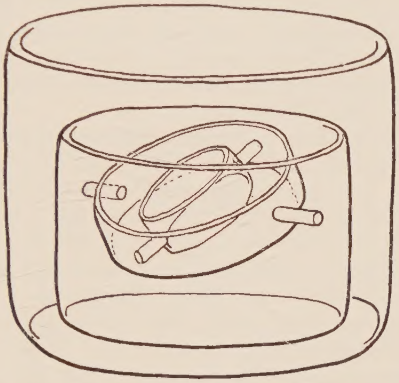


FIG. 1. Gimbals for tilting the specimen into positions required for drawing or measuring.

The abdomen and the pregenital prominences of each species examined have been drawn with some care from more than one aspect as I have found them useful in separating species. The shape of these parts is not so easily influenced by the site of attachment of the parasite, but on the other hand there is often a difference in the shape of these parts of a young individual and those of an old one. The characters of the immature specimens are often less well defined than those of adult specimens, and the adult female seems to continue to grow and develop specific form for some time after eggs are first produced.

The positions of the legs on the body have been recorded wherever possible with an estimate of the range of variability.

The amount of torsion and its direction is very variable; but worth recording because some species show little torsion and in others considerable torsion is the rule. In some species, such as *L. barnimiana*, the torsion is not only variable in direction and extent in different specimens but often changes its direction along the length of the one individual.

Cunnington (1914) remarks on the rarity of copepod parasites on the fish he collected from Lake Tanganyika. Lake Nyasa, however, seems to be very rich in species. More information is required about the seasonal distribution of the different species. Miss R. H. Low tells me that she found *Lernaea* on many of the specimens of *Bagrus* that she collected in August and that by November the *Bagrus* were free of parasites but the *Tilapia* were infected. She had the impression that the parasites had transferred their attentions from *Bagrus* to *Tilapia*; but an examination of the specimens shows that there are two distinct species of *Lernaea* involved, *L. bagri* and *L. tilapiae*, described below.

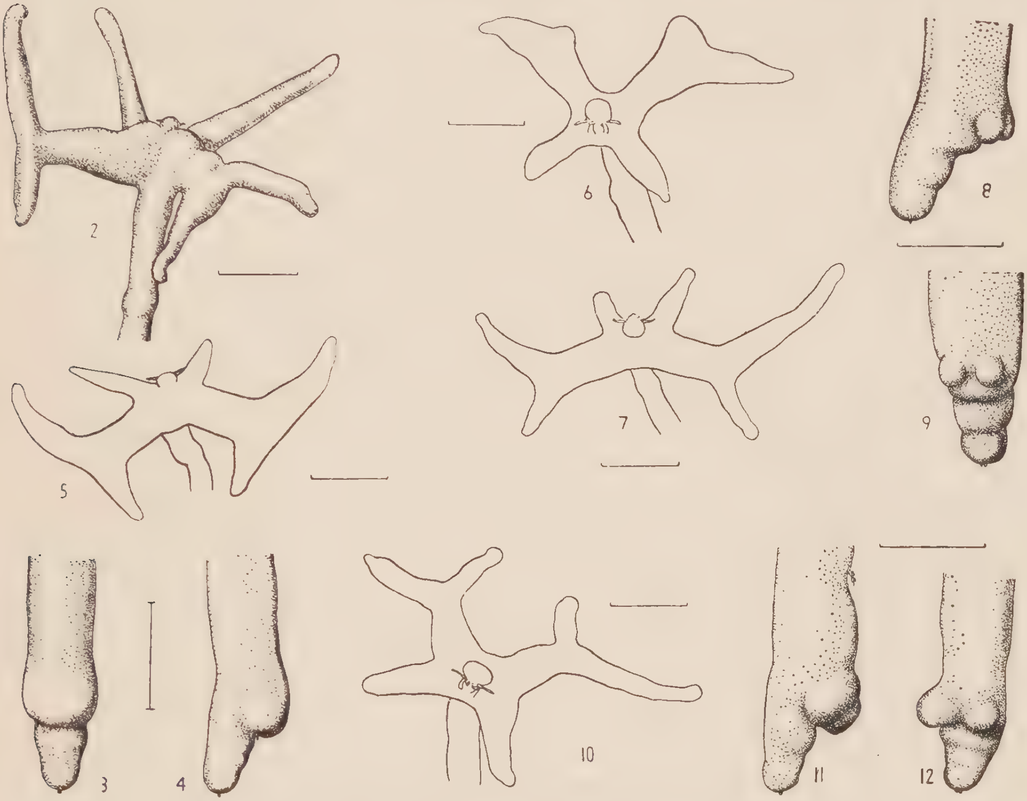
Lernaea cyprinacea Linnaeus

FIGS. 2–12.

1746 *Lernea tentaculis quatuor* Linnaeus, *Fauna Svecica*: 367, pl. 2.
1758 *Lernaea cyprinacea* Linnaeus, *Syst. Nat.*: 655.
1783 ,, ,, : Barbut, *Gen. Vermium*: 67, pl. 7, fig. 3.
1822 *Lerneocera cyprinacea* (Linnaeus) Blainville, *Journ. Phys.* **95**: 377.
1835 *Lernaeocera* ,, : Burmeister, *Nova Acta Leop. Carol.* **17**: 309, pl. 24 A, figs. 1–3.
1850 ,, ,, : Baird, *Brit. Entomost*: 343, pl. 35, fig. 13.
1904 ,, ,, : Hofer, *Handb. Fischkrankheit*, München: 144, fig. 95 and p. 119 [fide Pesta 1934].
1909 ,, ,, : Neresheimer, Brauer: *Süsswasserfauna Deutschl.* **11**: 77, fig. 326.
1913 ,, ,, (part): T. and A. Scott, *Brit. Parasit. Cop.*, Ray Soc. London: 154, pl. 50, figs. 4–5 [not figs. 1–3].
1917 *Lernaea cyprinacea*: Wilson, *Proc. U.S. Nat. Mus.* **53**: 4, 39.
1918 ,, ,, : Wilson, *Bull. U.S. Bur. Fish.* **35**: 193, 196, pl. 15, fig. 86.
1925 ,, (*Lernaeocera*) *elegans*: Leigh-Sharpe, *Parasitology*, **17**: 245, text-figs. 1–5.
1927 ,, *elegans*: Nakai, *J. Fish. Inst. Tokyo*, **23**: 39, pls. 2–4, text-figs. 1–7.
1927 ,, *cyprinacea*: Okada, *Annot. Zool. Jap. Tokyo*, **11**: 185, text-figs. 1–2.
1928 ,, *elegans*: Matsui and Kumada, *J. Fish. Inst. Tokyo*, **23**: 101, pls. 5–7.
1932 ,, *cyprinacea*: Monod. *Ann. Parasit. hum. comp.* **10**: 362, text-figs. 8 H, 11, 12.
1933 ,, ,, : Gurney, *Brit. Fresh-water Cop*, Ray Soc. Lond. **3**: 338 ,text-figs. 1969, 1971–1983.
1933 ,, *carassii* Tidd, *Ohio J. Sci.* **33**: 465, pl., figs. 1–8.
1934 ,, *cyprinacea*: Markewitsch, *Ann. Mus. zool. polon.* **10**: 234, pl. 45, fig. 8.
1934 ,, ,, : Pesta, *Tierwelt Deutschl.* **29**: 42, text-fig. 25.
1937 ,, ,, : Markewitsch, *Cop. Parasit. Binnengewäss. U.S.S.R.*, Kiev: 98, pl. 8.
1937 ,, ,, : Wagler, *Tierwelt Mitteleuropas*, Crust. **2**, 2a: 179, text-fig. 542.
1939 ,, ,, : Yamaguti, *Vol. Jubil. Prof. S. Yoshida* **2**: 475, pl. 30, figs. 156–165.

The material in the British Museum consists of two specimens found by Dr. Gurney on a specimen of *Carassius carassius* (L.) from Sweden in the Museum fish collection; a specimen from Canon Norman's collection which was labelled '*L. esoscina* from Prof. Heller' (this specimen is unfortunately without record of host or locality); thirty or more specimens from Japan presented by Dr. Gurney, and finally a few microscope slides of the type specimens of *L. elegans* presented by Mr. Leigh-Sharpe.

I have little to add to the excellent descriptions and figures given by many of the authors listed above, Gurney (1933) in particular; the shape of the anchor is, however, rather more variable than these descriptions indicate. The most typical arrangement is that of the Swedish specimen (Fig. 2), if the right dorsal arm which is distorted is ignored; the arms are all rather long and slender and the dorsal arms are T-shaped. This is the arrangement shown in nearly all figures of European specimens from Linnaeus, 1746 to Monod, 1932, and Gurney, 1933. Very few of the Japanese specimens are quite like this, there is a tendency for the dorsal arms to be Y-shaped (Figs. 5–7), and the posterior fork of the Y is often reduced. Prof. Heller's specimen (Figs. 10–12) of unknown origin is very like the Japanese specimens . The pregenital prominence of *L. cyprinacea* is generally described as 'simple or only slightly indented' (Wilson, 1918, p. 193, key). It is simple in the Swedish specimens (Figs. 3 and 4). The Japanese specimens have a distinctly double pregenital prominence (Figs. 8 and 9). Prof. Heller's specimen again agrees with the Japanese specimens rather than with the Swedish ones. Markewitsch (1937) also gives a figure of a specimen with a bilobed pregenital prominence, but he does not say from what part of the U.S.S.R. it came. None of the characters of *L. elegans* given by Leigh-Sharpe are valid for distinguishing between the Japanese form and the European. No 'auricular expansions' are now visible on the specimen from which Leigh-Sharpe's Fig. 3 was based; possibly the artist saw some folds of chitin. In this figure are shown what are called 3-segmented uncinate thoracic appendages, but an examination of the specimen shows that these are not appendages at all but are the badly fixed internal tissues which can be seen only by focusing well below the surface of the body, as Monod (1932) has already pointed out. Leigh-Sharpe's types of *L. elegans* are the same form of *L. cyprinacea* as the Japanese specimens I have seen.



Figs. 2–12. *Lernaea cyprinacea* Linnaeus

Figs. 2–4, specimen from Sweden; Fig. 2, dorsal view of anchor; Fig. 3, ventral view of pregenital prominence and abdomen; Fig. 4, lateral view of the same; Figs. 5–9, specimens from Japan; Figs. 10–12, specimen from Prof. Heller. The line near each figure is 1 mm. drawn to the same scale.

I have looked at the appendages of the Swedish and Japanese specimens with some care, but have been unable to find any difference, the setation of the legs is precisely the same in both (Table 1). The positions of the legs on the body of five Japanese specimens were measured; there was considerable variation, particularly of the anterior legs, but the positions of the five pairs of legs do not enable the Japanese and European specimens to be separated from one another. The positions of the five legs were 6–9, 16–20, 42–45, 73–74, and 90–92 per cent. of the total body length distant from the most anterior part of the head, respectively.

There is little doubt that *L. carassii* Tidd is the Japanese or *elegans* form of *L. cyprinacea.*

Lernaea barnimiana (Hartmann)

FIGS. 13–28

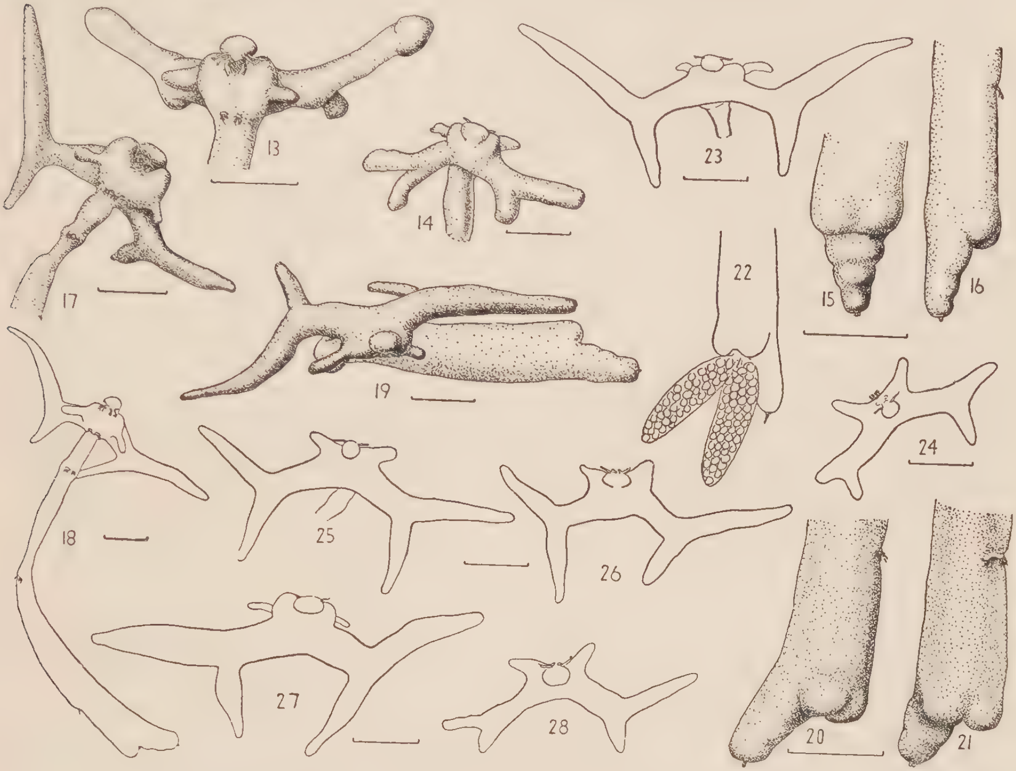
1865 *Lernaeocera barnimiana* Hartmann, *Naturges.-med. Skizze Nillander*: 206.
1870 ,, *barnimii* Hartmann, *Arch. Anat. Phys. Wiss. Med.* **1870**: 726, pls. 17–18.
1871 ,, ,, : Hartmann, *S. B. naturf. Fr. Berl.*: 60.
1914 ,, *temnocephala* Cunnington, *Proc. Zool. Soc. Lond.* **1914**: 827, pl. 1, figs. 8–9, text-fig. 1 C.
1917 *Lernaea barnimii*: Wilson, *Proc. U.S. Nat. Mus.* **53**: 38.
1918 ,, *temnocephala*: Wilson, *Bull. U.S. Bur. Fish.* **35**: 193, 196, pl. 15, fig. 87.
1918 ,, *barnimii*: ibid.: 193, 196, pl. 15, fig. 94.
1940 ,, *temnocephala*: Brian, *Boll. Idrobiol. Caccia Pesca*, **1**: 50, pl., figs. A–F.
1944 ,, *barnimiana*: Capart, *Bull. Mus. Hist. nat. Belg.* **20** (24): 2, text-fig. 1.

Several specimens of this species were taken from a fish, *Labeo forskalii* Rüppell, caught in Lake Edward by Dr. E. B. Worthington in 1931. The heads of the parasites were buried in the flesh of the head and inside the mouth of the fish. The Museum also possesses the single specimen on which Cunnington founded *L. temnocephala.* Thanks to the kindness of Dr. Capart I have seen three of the specimens he described from the Belgian Congo.

The length of the adult female, judging from the literature, ranges from 7 mm. to 12 mm. (Capart's 1944 figs.); Hartmann's 1870 record of a range of from 10 mm. to 14 mm. may include the anterior arms of the anchor in the length. The British Museum specimens range from 8·2 mm. to 10·8 mm. in length.

The positions of the five pairs of legs of seven of the Lake Edward specimens give the following ranges measured in percentages of the total body length: 7·2–9·8, 19–24, 41–51, 73–79, and 89–92 per cent. respectively. The positions of the legs on the specimens kindly lent me by Dr. Capart agree, but two other specimens which he figures (Capart, 1944, fig. 1, A and E) appear to have the first and second legs a little farther forward; this may, however, be owing to the foreshortening which is inevitable when curved specimens are drawn. Hartmann's (1870) drawings are not very reliable and I attach no importance to the fact that the position of the fourth pair of legs in his Fig. 1 is only 65 per cent. of the body length from the anterior. The positions for Cunnington's type of *L. temnocephala* are 8, 18, 44, 79, and 92 per cent. respectively. The variations in the positions of the legs seems to be quite independent of the size of the specimen, i.e. there is no heterogony with respect to this character.

The torsion of the specimens I have seen was variable; that between successive pairs of legs never exceeded 90° and was usually much less. It could be either sinistral or dextral and frequently changed its direction. The total torsion of the whole body was not more than 120° in any of the twelve specimens examined.



FIGS. 13–28. *Lernaea barnimiana* (Hartmann).

Figs. 13–16, Cunnington's specimen from L. Tanganyika, named by him *temnocephala*; Fig. 13, ventral view of anchor; Fig. 14, dorsal view; Fig 15, ventral view of abdomen and pregenital prominence; Fig. 16, lateral view of the same. Figs. 17–28, specimens from L. Edward. Fig. 17, ventral view of anchor; Fig. 18, ventral view of another specimen; Fig. 19, anterior view of the latter; Figs. 20 and 21, posterior end of this specimen; Fig. 22, posterior end of a specimen with egg-sacs; Figs. 23–28, anchors of other specimens from L. Edward, all from the same fish. The line near each figure is 1 mm. drawn to the same scale.

The arms of the anchor are rather variable in shape and arrangement, as Capart (1944) has shown. The most usual arrangement is for the part between the head and the first legs to be swollen and more or less globular. The ventral arms are simple in shape and very short. The usual arrangement is for the ventral arms to be directed outwards; this was so in all the Lake Edward material, in Cunnington's specimen from the Nile, and in most of Capart's material from the Belgian Congo. In some of Capart's specimens and also in the figure accompanying Hartmann's description (Hartmann, 1870, fig. 1), on the other hand, the ventral processes are directed anteriorly. With regard to the bifurcating dorsal arms, Hartmann's figure shows both branches equal to one another and both diverging slightly away from the body; but in his description he says that the anterior branch is the longer of the two and is the more outwardly directed. The normal condition seems to be for the anterior branch to diverge widely from the body while the posterior branch is directed slightly inwards (Figs. 17, 18, 23, &c.). The angle between the two branches is normally an open and continuous curve; but sometimes as in Figs. 25, 27, 28, &c. there is a more or less distinct angle. The Y-shaped condition of the arms of the *temnocephala* holotype (Fig. 14) is unusual but within the range of variation of *L. barnimiana.*

The pregenital prominence is distinct and bilobed (Figs. 15, 16, 20, and 21); but from some aspects it may appear to be a single broad process.

The abdomen is distinctly 3-segmented and may continue the line of the body or be set at an angle. Each segment is a little smaller than the preceding one. Hartmann does not describe the abdomen of his specimens, and his figure and those of Brian (1940) are of little value in this respect. Cunnington's *temnocephala* specimen (Figs. 15 and 16) is normal.

The setation of the legs is the same as that of *L. cyprinacea* (Table 1, p. 4). I have cleared Cunnington's type of *temnocephala* with potassium hydroxide, and this has got rid of the twists and distortions he mentions and has enabled me to examine the setation of its legs; and as with the other characters investigated I can find no difference between this specimen and the Lake Edward specimens and I have no hesitation in placing *L. temnocephala* (Cunnington) in the synonymy of *L. barnimiana*, as Capart (1944) has already suggested.

Lernaea piscinae sp. nov.

FIGS. 29–34

Holotype, Reg. No. 1949.8.14.1, and many paratypes, all females, in the British Museum. The parasites were found heavily infesting a Cyprinid fish, *Hypophthalmicthys nobilis* (Richardson) cultivated by the Chinese on a fish farm at Singapore. Four fish heavily infested with the parasites, over 50 per fish, were presented to the Museum by Mr. W. Birthwhistle in 1929. Length of holotype 10·4 mm.; the length of 10 paratypes ranged from 9·7 mm. to 12·4 mm. The positions of the five pairs of legs of these eleven specimens were 5–7, 13–14, 31–38, 69–74, and 91–93 per cent. of the total length from the most anterior part of the head. All the specimens of this species were very much alike; seven out of the eleven specimens had a curve between legs 2 and 3 as in Fig. 29. Three of the remainder were straight and the other had an additional bend between legs 1 and 2.

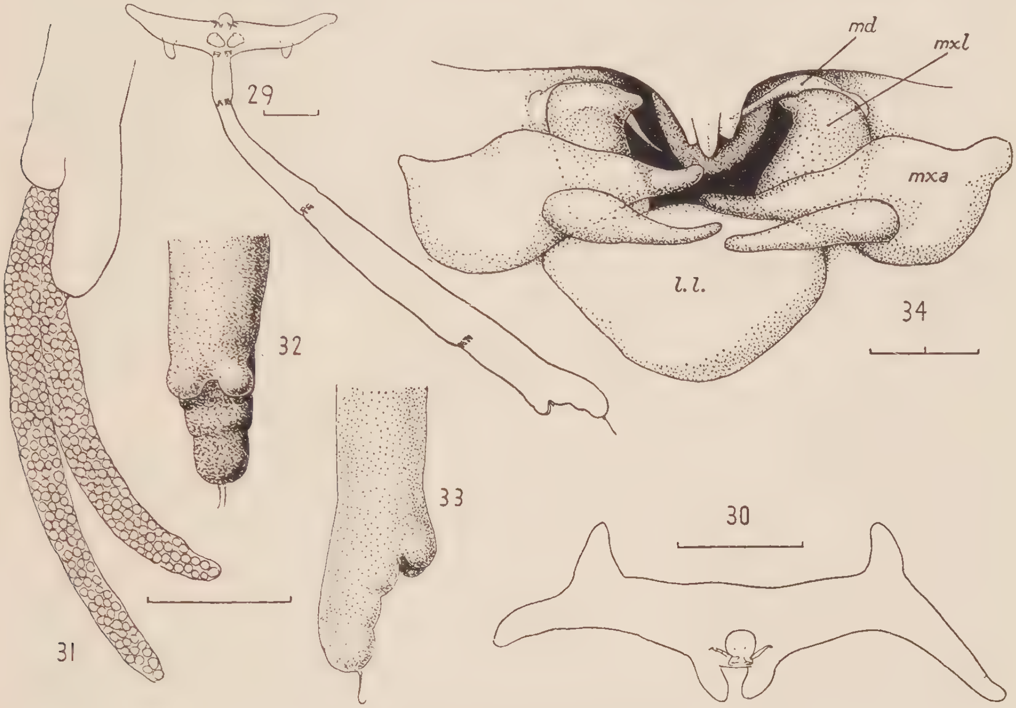
The main part of the anchor forms a bar set at right angles to the body like the cross-bar of a T (Figs. 29 and 30). The middle of the bar is considerably thicker than the part of the body joined to it, and tapers gradually towards the ends, which are also curved slightly in an antero-ventral direction. From about the middle of each half of the cross-bar there is a short dorsal process. There is also a pair of ventral processes between the head and the legs 1; these are separated by a distance about equal to the width of the head and are directed slightly inwards towards one another.

Except for slight swellings at the positions of the legs the body increases in thickness very gradually from before backwards.

The abdomen (Figs. 32–33) makes a slight angle with the body; it is nearly 1 mm.

long and less than ½ mm. wide. Ventrally it is distinctly 3-segmented; but the dorsal profile forms an even, continuous curve.

The pregenital process is double, the two lobes being small but well defined and quite separate from one another.



FIGS. 29–34. *Lernaea piscinae* sp. nov.

Fig. 29, ventral view of holotype; Fig. 30, anterior view of anchor; Fig. 31, lateral view of posterior end of a paratype with egg-sacs; Fig. 32, ventral view of abdomen and pregenital prominences of holotype; Fig. 33, lateral view of the same; Fig. 34, mouth and associated appendages. *l.l.*, lower lip; *md.*, mandible; *mxa.*, maxilla; *mxl.*, maxillule. The line near each figure is 1 mm. drawn to the same scale except that near fig. 34 which is 0·02 mm.

The egg-sacs (Fig. 31) are very long, about 4 mm., three-quarters of their length projecting beyond the tip of the abdomen.

The setation of the legs is the same as in *L. cyprinacea* (Table 1).

The mouth parts (Fig. 34), as far as I was able to make out, are the same as for other species.

Lernaea diceracephala (Cunnington)

FIGS. 35–39

1914 *Lernaeocera diceracephala* Cunnington, *Proc. Zool. Soc. Lond.* **1914:** 824, pl. 1, figs. 1–3, text-fig. 1 A.
1917 *Lernaea diceracephala*: Wilson, *Proc. U.S. Nat. Mus.* **53:** 38.
1918 ,, ,, : Wilson, *Bull. U.S. Bur. Fish.* **35:** 192, 194, pl. 15, fig. 90.
1944 ,, ,, : Capart, *Bull. Mus. Hist. nat. Belg.* **20** (24): 7.

Holotype, Reg. No. 1914.12.2.1, and one paratype in the British Museum; I have selected the more perfect of the two specimens as the holotype. These are the only specimens known and were taken from the gill arches of a large *Clarias mossambicus* Peters, caught at Sumbu, Lake Tanganyika, by Dr. Cunnington in 1904. Capart (1944) includes the species in his paper because part of Lake Tanganyika lies in the Belgian Congo.

Cunnington's description of the two specimens is very good; but he describes the left arm as being complete in the better specimen when in fact the tip has been broken off.

The length of the holotype measured as if straightened out is 9·1 mm. The five pairs of legs come in positions 10, 23, 50, 71, and 92 per cent. of the total length from the most anterior part of the head.

I have made drawings of the two specimens which I hope are an improvement on Cunnington's photographs, and which show how similar to one another are the bends and constrictions in the body.

Lernaea bagri sp. nov.

FIGS. 40–43

Holotype, Reg. No. 1949.8.14.9, and over two dozen paratypes, all females, in the British Museum.

The copepods were taken from *Bagrus meridionalis* in Lake Nyasa by Miss R. H. Low, 14 Aug. and 22 Sept. 1946.

The length of the holotype is 12·1 mm.; that of twenty-four adult females carrying egg-sacs ranged from 9·9 mm. to 14·2 mm.

The body of a few of the slender, young-looking specimens is straight, but usually it is curved as shown (Fig. 40), and in these there is a torsion which in this species nearly always changes its direction. In all the specimens I have examined for this purpose the torsion is first sinistral and then dextral. In the holotype, for example, the torsion between legs 1 and 2 is 40° sinistral, between legs 2 and 3 it is 80° dextral, and between legs 3 and 4 it is a further 50° dextral, after which there is no further torsion. The resultant torsion between the head and the abdomen is about 90° dextral.

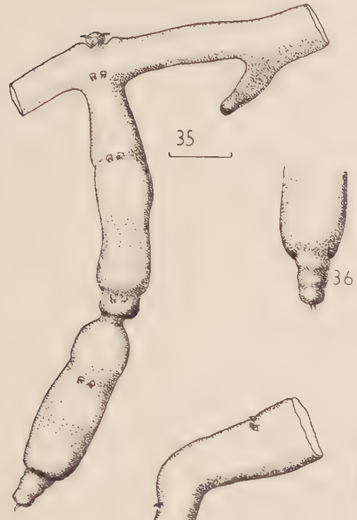
The arms of the anchor are heavily chitinized, in contrast to those of the next species to be described, *L. tilapiae*, and lie in a plane approximately at right angles to the body. The head is placed centrally over the cross formed by the four arms. The ventral arms are straight and the dorsal ones are curved towards them. There is a tendency for each arm to end with a rounded knob.

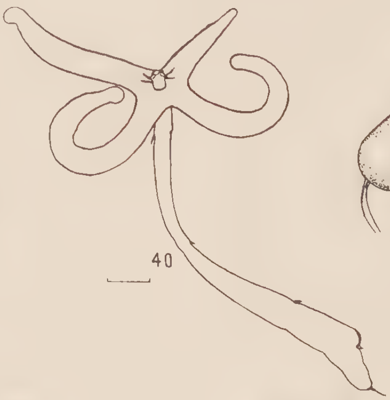
The positions of the legs are rather variable in this species. Six specimens were examined, and the positions of legs 1 to 5 gave the following ranges respectively: 7–10, 18–22, 42–52, 73–78, and 90–93 per cent. The setation of the legs is the same as that of *L. cyprinacea* (Table 1).

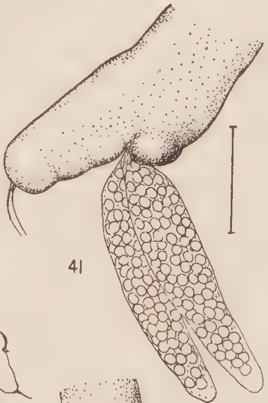
The abdomen (Figs. 41–3) is set at a slight angle to the line of the body; it is straight and slightly tapering; the three segments are very indistinctly separated.

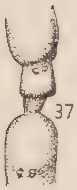
The pregenital prominence is bilobed. Sometimes the lobes are prominent and bulge laterally beyond the greatest width of the body, but usually, as in the holotype, they are not very prominent from the ventral aspect (Fig. 43).

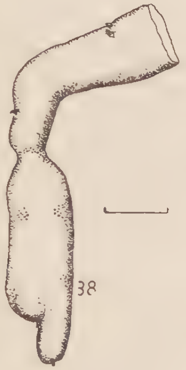
The egg-sacs (Fig. 41) are about 2½ mm. long and ½ mm. wide at their greatest width, which lies at about the proximal third of the length.

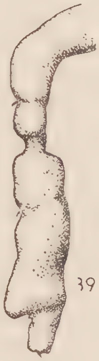


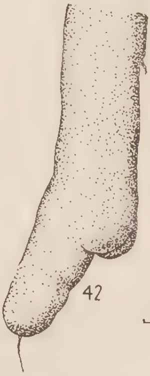


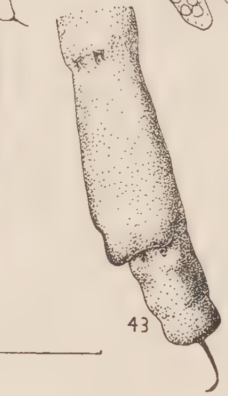












FIGS. 35–39. *Lernaea diceracephala* (Cunnington).

Fig. 35, ventral view of holotype; Fig. 36, dorsal view of abdomen; Fig. 37, constriction between legs 3 and 4 from a slightly different aspect from that of Fig. 35; Fig. 38, lateral view of paratype; Fig. 39, similar view of part of holotype.

FIGS. 40–43. *Lernaea bagri*, sp. nov.

Fig. 40, dorsal view of holotype; Fig. 41, lateral view of abdomen and egg-sacs of a paratype; Fig. 42, lateral view of abdomen and pregenital prominences; Fig. 43, ventral view of the same. The line near each figure is 1 mm. drawn to the same scale.

Lernaea tilapiae sp. nov.

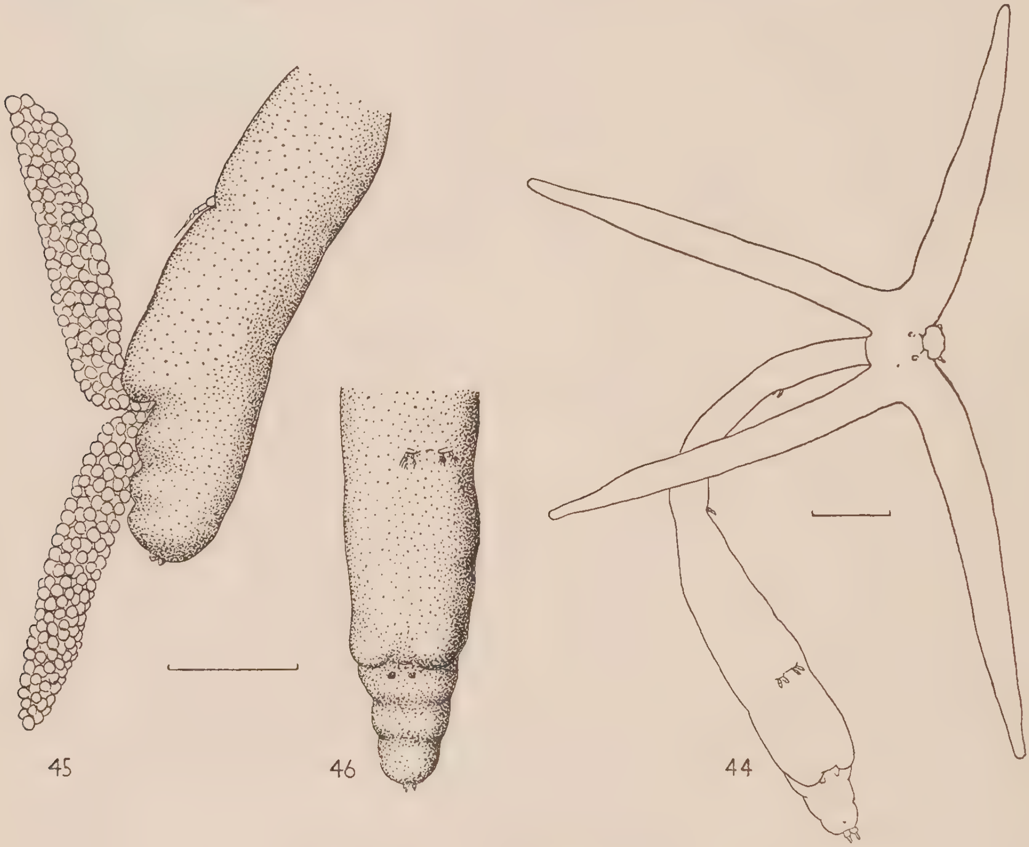
FIGS. 44–46

Holotype, Reg. No. 1949.8.14.17, and a few paratypes, all females, in the British Museum.

The parasites were collected by Miss R. H. Low from Lake Nyasa and were taken from the mouth and gills of *Tilapia squamipinnis* Günther and *T. lidole* Trewavas caught in Lake Nyasa 22 Nov. 1946.

The length of the holotype measured from the front of the head to the tip of the abdomen is 9·2 mm. Five other females bearing egg-sacs ranged from 7·5 mm. to 11 mm. in length.

The body is comparatively slender from the head to as far as legs 3 and is usually curved here, so that the anterior part of the body is at right angles to the broad part behind legs 3 (Fig. 44). In the holotype the torsion is dextral 45° between legs 2 and 3, dextral 90° between legs 3 and 4, and dextral a few degrees beyond legs 4, the total torsion being dextral through about 140°. The only torsion in one of the paratypes is a sinistral one of 45° between legs 3 and 4.



FIGS. 44–46. *Lernaea tilapiae* sp. nov.

Fig. 44, dorsal view of holotype; Fig. 45, lateral view of abdomen, pregenital prominence, and egg-sacs; Fig. 46, ventral view of the same without egg-sacs. The line near each figure is 1 mm. drawn to the same scale.

The anchor bears four long straight slender arms as figured (Fig. 44); these lie in a plane nearly parallel to that of the body; the posterior pair are directed backwards and are only slightly divergent; the anterior pair diverge widely, with the head placed in the angle between them. The four arms of the anchor are about equal in length to one another and more than half the length of the body. They are only lightly chitinized and are much softer than those of the last species described, *L. bagri*.

The legs come in positions 8, 25, 50, 77, and 90 per cent. of the body length from the anterior end. The setation of legs 1 to 4 is the same as for *L. cyprinacea* (Table 1, p. 4).

The abdomen is divided into three segments by transverse ventral constrictions which give it a characteristic profile (Fig. 45). The dorsal profile of the abdomen is slightly arched.

The pregenital prominence is bilobed; the two lobes overhang the abdomen slightly, but their ventral surface is in line with that of the body in front (Fig. 45).

The egg-sacs are about 2·5 mm. long and 0·5 mm. wide, slightly tapering towards each end. Miss Low records that in life the parasite is brown in colour and the eggs are jade-green.

Lernaea barilii sp. nov.

FIGS. 47–60

Holotype, Reg. No. 1949.8.14.21, and about 10 paratypes, all females, in the British Museum.

The parasites were taken on a large specimen (500 mm. long) of *Barilius microlepis* Günther from Lake Nyasa by Dr. Christy in 1925, a piece of the flank of the fish with the copepods embedded being preserved together with a note to the effect that there were more parasites on the tongue, &c. I have only seen the specimens from the flank.

The length of the holotype is 8·3 mm. with the positions of legs 1 to 5 at 8·4, 20, 47, 77, and 92 per cent. of the total body length from the anterior end respectively. The positions on paratype Reg. No. 1949.8.14.24 are 8, 19, 47, 77, and 93 per cent. The setation of the legs is the same as in *L. cyprinacea* (Table 1, p. 4).

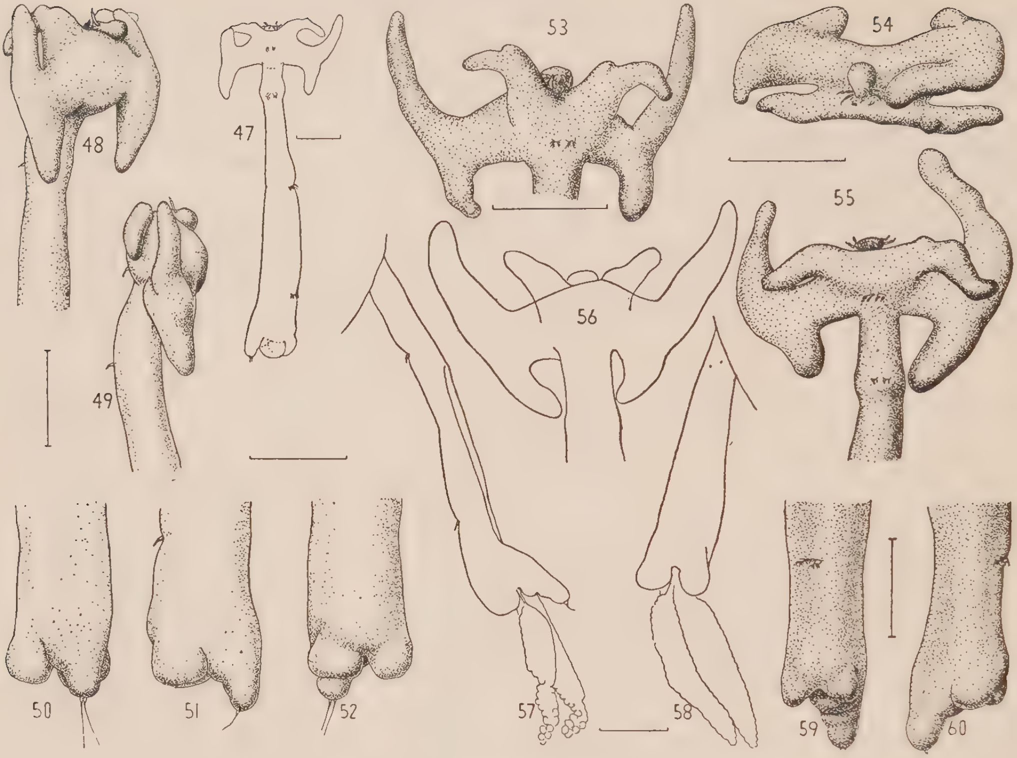
The body is straight and short, widest at the posterior end. In the two specimens which were examined in detail the torsion was about 80°. In the holotype most of the torsion was between legs 2 and 3, and in the paratype examined it was between legs 3 and 4; it was sinistral in the holotype and dextral in the paratype.

The arrangement of the anchor is best understood with reference to Figs. 47–49 and 53–55. There are a pair of lateral T-shaped arms with the cross-bar of the T running more or less parallel to the body; the basal part of these arms is short and thick. Anterior and ventral to the dorsal arms are a pair of simple arms directed outwards, with in nearly all cases a small knob facing anteriorly.

The pregenital prominences are very large and distinctly separated from one another; they reach almost to the end of the abdomen in some specimens (Figs. 40, 50–52, 57–60).

The abdomen, particularly the part composed of the last two segments, is very small and set at an angle to the body. All three segments are clearly marked off from one another ventrally; the first is very much broader than the other two (Figs. 51 and 60).

The egg-sacs of the holotype were about 2.75 mm. long, broadest in the middle and tapering towards each end (Fig. 58).



FIGS. 47–60. *Lernaea barilii* sp. nov.

Fig. 47, ventral view of holotype; Fig. 48, dorso-lateral view of anchor; Fig. 49, lateral view of the same; Fig. 50, dorsal view of posterior end of holotype; Fig. 51, lateral view of the same; Fig. 52, ventral view of the same; Fig. 53, ventral view of anchor of a paratype; Fig. 54, anterior view of another paratype; Fig. 55, ventral view of the same; Fig. 56, anchor of a specimen drawn *in situ* by clearing in benzyl alcohol; Fig. 57, lateral view of specimen with egg-sacs before removing from the fish (the specimen has shrunk and collapsed dorsally); Fig. 58, ventral view of holotype with egg-sacs before treatment with hydroxide; Fig. 59, ventral view of the posterior end of a paratype; Fig. 60, lateral view of the same. The line near each figure is 1 mm. drawn to the same scale.

Lernaea palati sp. nov.

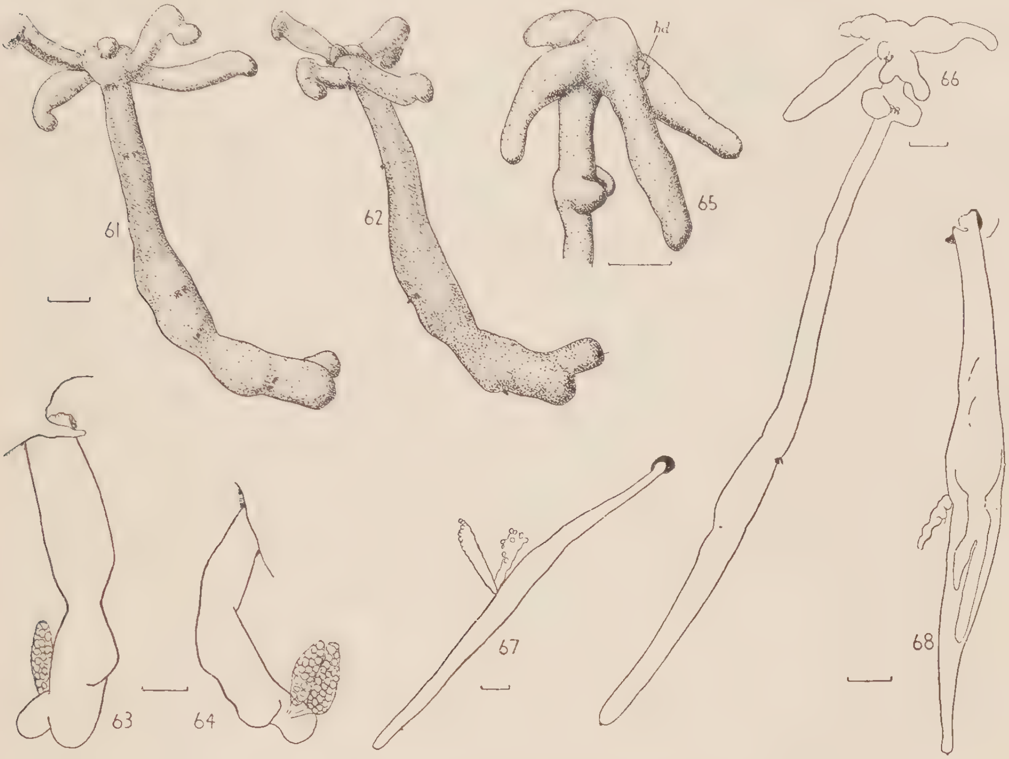
FIGS. 61–64

Holotype, Reg. No. 1949.8.14.26 in the British Museum. The single specimen on which this species is based was from the roof of the mouth of a fish, *Haplochromis chrysonotus* (Boulenger) from Vua on Lake Nyasa, collected by Dr. Christy in 1925. The hind end of the parasite projected through a gill slit and was visible externally.

The length of the specimen, allowance being made for bends, is 12·7 mm. The body from the first pair of legs to half-way between legs 2 and 3 is cylindrical, about 0·7 mm. thick; the section containing legs 3 is broader, about 1·2 mm. across; there is a waist between legs 3 and 4; the body bends backwards and to the left here and bulges again to a thickness of 1·2 mm. in front of legs 4.

The abdomen is tilted dorsally at an angle of about 45°; it is a simple cylinder rounded at the end about 1 mm. long and 0·7 mm. broad without any sign of segmentation.

The five pairs of legs are placed in positions 8·7, 26, 55, 80, and 93 per cent. of the body length from the anterior end. The setation is the same as that of *L. cyprinacea* (Table 1, p. 4). There is little torsion.



Figs. 61–64. *Lernaea palati* sp. nov.

Fig. 61, ventral view of holotype; Fig. 62, lateral view; Fig. 63, holotype embedded in roof of mouth of fish; Fig. 64, another view of the same showing egg-sacs.

Figs. 65–68. *Lernaea longa*, sp. nov.

Fig. 65, lateral view of holotype showing anchor and swelling by legs 2. *hd*, head; Fig. 66. A paratype with the left ventral arm of the anchor distorted; Figs. 67 and 68, the externally visible parts of two other specimens embedded in the fish. The line near each figure is 1 mm. drawn to the same scale.

The anchoring arms (Figs. 61 and 62) are four in number, of medium length and uniform thickness, each with a bend or a kink near the end. The ventral pair is directed slightly forwards and the dorsal pair backwards to the same extent.

The head is not in line with the body, but inclined towards the angle between the ventral arms of the anchor.

The egg-sacs are comparatively short and broad, being about 1·5 mm. long and 0·5 mm. broad (Figs. 63 and 64).

Lernaea longa sp. nov.

FIGS. 65–68

Holotype, Reg. No. 1949.8.14.27, and half a dozen paratypes, all females, in the British Museum.

All the specimens were from a single specimen of *Lates niloticus* subsp. *longispinus* Worthington from Lake Rudolf, collected by Dr. E. B. Worthington in 1931. The parasites were embedded in the head and flanks of the fish.

The length of the holotype is 19 mm., with the five pairs of limbs in positions 6·3, 14, 36, 64, and 77 per cent. of the body length from the anterior end. Owing to the fact that the head is held ventrally between the ventral arms of the anchor, these measurements have been made from the most anterior part of the body, i.e. the central boss of the anchor. In paratype, Reg. No. 1949.8.14.29 (Fig. 66) the total length is 22 mm. with the legs in positions 5, 11, 32, 59, and 71 per cent. of the body length.

The body is long and slender with a conspicuous swelling in the region of legs 2, and from this swelling a pair of rounded processes project ventrally with the second pair of legs between them. There are slight swellings in the regions of legs 3 and 4.

Two examples will suffice to show how the torsion varies and may change its direction in this species. In the holotype the total torsion is a sinistral one of 110°, made up of a dextral torsion of 10° between legs 2 and 3 and a sinistral torsion between legs 3 and 4. In paratype Reg. No. 1949.8.14.29 the total torsion is a dextral one of 20°; this is the resultant of a sinistral torsion of 45° between legs 1 and 2, and of 135° between legs 2 and 3, followed by a dextral torsion of 90° between legs 3 and 4, and of 110° between legs 4 and 5.

The abdomen is very long, about a quarter of the total body length; it is in line with the rest of the body and tapers gradually to a rounded tip without any indications of segmentation. The pregenital prominence is ill defined.

The anchor has normally four simple more or less cylindrical arms as shown in Fig. 65. One of the ventral arms of specimen Reg. No. 1949.8.14.29 is branched, but this is evidently an abnormality probably caused by its meeting an obstruction during its growth into the flesh of the fish (Fig. 66). The ventral arms are about 5 times as long as they are broad and are directed backwards at an angle of about 45° to the body. The dorsal arms are a little shorter and are directed more nearly at right angles to the body.

The head is placed on the ventral side of the anchor in the fork between the ventral pair of arms.

None of the specimens had complete egg-sacs; the most complete was 3 mm. long, with a maximum width of 0·6 mm.

Lernaea haplocephala (Cunnington)

1914 *Lernaeocera haplocephala* Cunnington, *Proc. Zool. Soc. Lond.* **1914:** 826, pl. 1, figs. 4–7, text-fig. 1 B.
1917 *Lernaea haplocephala*: Wilson, *Proc. U.S. Nat. Mus.* **53:** 38.
1918 ,, ,, : Wilson, *Bull. U.S. Bur. Fish.* **35:** 193, 195, pl. 15, fig. 92.
1920 ,, ,, : Wilson, *Bull. Amer. Mus. Nat. Hist.* **43** (1): 5, pl. 3, figs. 20–22.

1923 *Lernaeocera bichiri* Kurtz, *S. B. Akad. Wiss. Wien.* **131**, Abt. 1: 332, pl. 2, figs. 1–11.
1927 *Lernaea haplocephala*: Brian, *Faune Colon. Fr.* **1**: 581, figs. 26–34.
1944 ,, ,, : Capart, *Bull. Mus. Hist. nat. Belg.* **20** (24): 7.

The British Museum possesses the twenty-seven specimens listed by Cunnington, from three species of *Polypterus* from Lake Tanganyika and the White Nile. I select as holotype the single specimen, Reg. No. 1914.12.2.3, taken from *Polypterus congicus* Boulenger collected from Lake Tanganyika by Cunnington himself and on which his description is largely based. *L. haplocephala* is probably the best known of the African species of *Lernaea* and has been found on several species of *Polypterus* in the White Nile, Belgian Congo, and Cameroons.

The species is easily recognized by the shape of the anchor and by the peculiar swelling in the region of legs 2; and it is unfortunate that Wilson (1920), in his eagerness to find characters in the appendages, should have added as a distinguishing character 'the small spherical terminal joint of the maxillipedes, with its four curved claws'. I have examined the maxillipedes of the holotype and of some of the paratypes and can find no distinguishing feature in them; they have five claws like every other species I have looked at. Wilson may have had a specimen with only four claws Brian describes and figures only three, but they are not easy to see and are difficult to count. There is, however, a character in which the appendages of *L. haplocephala* differ from those of all other species of *Lernaea* that I have been able to examine: there are only four setae on the terminal joints of the exopods of the first four pairs of legs (Table 2); other species have five setae here. The setation of these legs has been correctly figured by Kurtz and by Brian.

TABLE 2

Arrangement of the setae and spines on the legs of *Lernaea haplocephala*

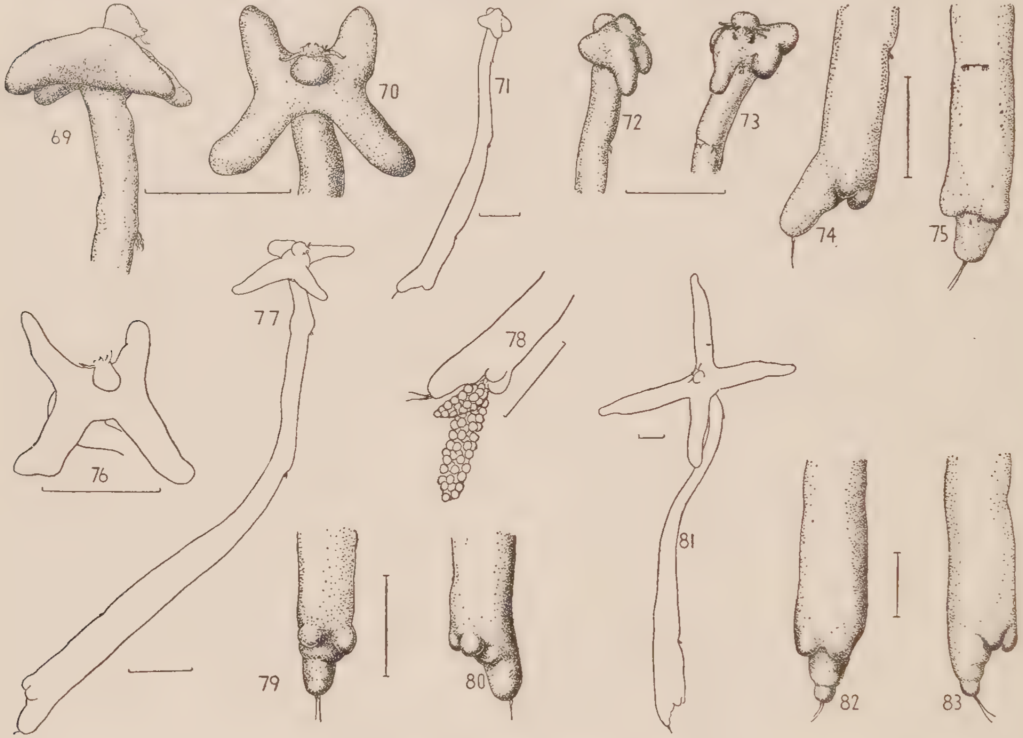
		Leg 1	*Leg 2*	*Leg 3*	*Leg 4*
Exopod	spines	1.1.2	1.1.3	1.1.3	1.1.3
	setae	1.1.**4**	1.1.**4**	1.1.**4**	1.1.**4**
Endopod	spines	0.0.2	0.0.2	0.0.2	0.0.2
	setae	1.1.4	1.2.4	1.2.4	1.2.3

Lernaea lophiara sp. nov.

FIGS. 69–80

Holotype, Reg. No. 1949.8.14.34, and several paratypes, all females, in the British Museum. The holotype was from the dorsal fin of *Lethrinops lethrinus* (Günther) from Lake Nyasa. The paratypes included very similar specimens from the dorsal fins of the following species of fish, all from Lake Nyasa: *Haplochromis prostoma* Trewavas, *H.* sp. cf. *micrentodon* Regan, *Rhamphochromis lucius* Ahl, *Pseudotropheus tropheops* Regan, *Diplotaxodon argenteus* Trewavas, and also buried in the edge of the operculum of *Lethrinops praeorbitalis* Regan. Other paratypes which differ from the holotype only in having very short arms to the anchor were found in the dorsal fins of *Haplochromis breviceps* Regan and *Tilapia melanopleura* Dumeril. Specimens which I have left *in situ* and not examined but are presumably the same species were found in the dorsal fins of *Haplochromis argyrosoma* Regan, *H. incola* Trewavas, *H. johnstoni* (Günther), and *H. nigritaeniatus* Trewavas.

The length of the holotype is 9·6 mm. with the legs in positions 6, 16, 42, 76, and 93 per cent. of the body length from the anterior end. The body is curved between legs 2 and 3, so that the axis of the anterior end of the body is approximately at right angles to the posterior end. The total torsion of the holotype is a dextral one of about 145°; this is made up of a dextral torsion between legs 2 and 3 of 85° and a further dextral torsion of 60° between legs 3 and 4.



Figs. 69–80. *Lernaea lophiara* sp. nov.

Fig. 69, lateral view of head and anchor of holotype from dorsal fin of *Lethrinops*; Fig. 70, anterior view of the same; Fig. 71, paratype Reg No. 1949.8.14.35 from dorsal fin of *Haplochromis*; Fig. 72, lateral view of anchor; Fig. 73, ventral view of the same; Fig. 74, lateral view of abdomen and pregenital prominences of the same paratype; Fig. 75, ventral view of the same; Fig. 76, anterior view of anchor of paratype Reg. No. 1949.8.14.45 from operculum of *Lethrinops*; Fig. 77, general view of this paratype; Fig. 78, posterior end with egg-sacs of paratype Reg. No. 1949.8.14.46 from operculum of *Lethrinops*; Fig. 79, ventral view of abdomen and pregenital prominences of paratype Reg. No. 1949.8.14.45; Fig. 80, lateral view of the same.

Figs. 81–83. *Lernaea* cf. *lophiara*

Fig. 81, specimen from operculum of *Rhamphochromis* Reg. No. 1949.8.14.47; Fig. 82, ventral view of abdomen and pregenital prominences of this specimen; Fig. 83, lateral view of the same. The line near each figure is 1 mm. drawn to the same scale.

The lengths of seven paratypes range from 6·7 mm. to 9·8 mm., the positions of the five pairs of legs ranging from 5–6·5, 17–18, 42–47, 73–79, and 93–94 per cent. of the body length from the anterior end respectively. Only in two specimens, one of them the holotype, is the torsion of the body more than 90°. There is nearly always some torsion, however, and also a curvature in the region of legs 2 and 3.

The anchor has four simple arms. In most of the specimens (Figs. 69, 70, 76, 77), including the holotype from the dorsal fin of *Lethrinops praeorbitalis* and paratype Reg. No. 1949.8.14.45 from the operculum of the same fish, the dorsal arms are a little longer than the ventral ones and tend to splay outwards towards the ends. In two other specimens (Figs. 71–73) from dorsal fins, one from *Haplochromis breviceps*, the other from *Tilapia melanopleura*, the arms of the anchor are very short.

The pregenital prominence is double in all specimens except one which is the smallest examined and measures 6·7 mm. in length.

The setation of the legs is the same as that of *L. cyprinacea* (Table 1, p. 4).

The egg-sacs are spindle-shaped and two or three times as long as the abdomen.

Lernaea sp. cf. *lophiara*

FIGS. 81–83

A fish of the species *Rhamphochromis lucius* Ahl bore three parasites: one on the fin is a typical example of *Lernaea lophiara*, the other two, one on the flank and the other on the operculum, are considerably larger than normal for that species and have very much larger arms to the anchor. The shape of the abdomen is also rather different. It may be found that these two specimens belong to a new species, but the comparatively well-developed condition of the arms of the anchor might be due to there being more space for them to grow in the body of the fish than there is in the fin. Against this, however, is the fact that the specimens of *L. lophiara* from the operculum of *Lethrinops praeorbitalis* do not differ in the size of the anchor or in other respects from specimens from the fins.

The lengths of the two specimens from the flank and operculum are 14·4 mm. and 13·7 mm. respectively. The anchor of the shorter specimen is damaged, that of the larger is shown in Fig. 81. The last segment of the abdomen is very small in these two specimens, the abdomen as a result being much more conical in shape than is typical for *L. lophiara* (Figs. 82–83). The positions of the five pairs of legs of the larger specimen are 5, 17, 46, 73, and 94 per cent. of the body length from the anterior end respectively. The setation of the legs is the same as that of the other specimens.

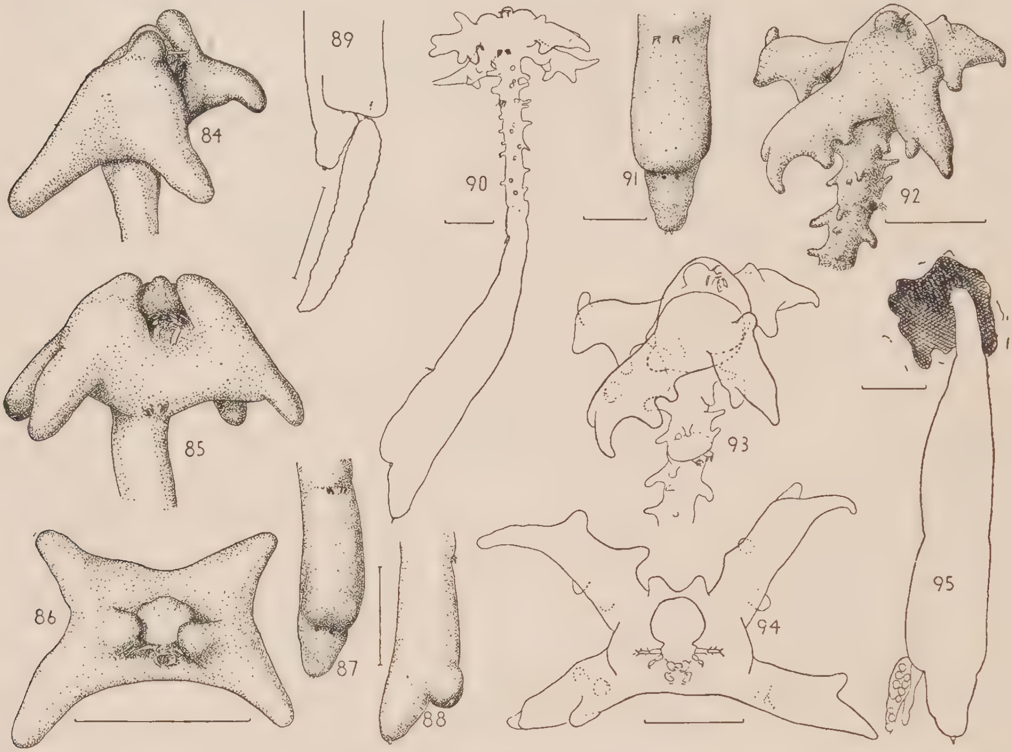
Lernaea bistricornis sp. nov.

FIGS. 84–88

Holotype Reg. No. 1949.8.14.49 in the British Museum. This species has to be described from a single specimen found at the base of a pelvic fin of *Cardio-pharynx schoutedeni* Poll from Lake Tanganyika.

The length of the holotype is 8·7 mm. The body is curved evenly into a semicircle, and there is a sinistral torsion of about 90°. The positions of the five pairs of legs are 8, 21, 45, 76, and 94 per cent. of the body length from the anterior end respectively. The setation of legs 1 and 2 cannot be seen, but that of legs 3 and 4 is the same as that of *L. cyprinacea* (Table 1, p. 4).

The anchor (Figs. 84–86) has six short, blunt processes, three on each side. There is a dorsal pair and a ventral pair, both of which are directed outwards and backwards. These are similar to those of some specimens of *L. lophiara*; but in addition there is a pair of small knobs on each side of the head which reach over as if to protect it.



FIGS. 84–88. *Lernaea bistricornis* sp. nov.

Fig. 84, latera lview of anchor; Fig. 85, ventral view; Fig. 86, anterior view of the same; Fig. 87, ventral view of abdomen and pregenital prominence; Fig. 88, lateral view of the same.

FIG. 89. *Lernaea barbicola* Leigh-Sharpe. Abdomen, pregenital prominence, and egg-sac.

FIGS. 90–95. *Lernaea tuberosa* sp. nov.

Fig. 90, ventral view of holotype; Fig. 91, abdomen and pregenital prominence; Fig. 92, lateral view of anchor; Fig. 93, the same seen as a transparent object; Fig. 94, anterior view of anchor; Fig. 95, the visible part of the parasite protruding from the hole in the side of the fish. The line near each figure is 1 mm. drawn to the same scale.

The pregenital prominence is well defined (Figs. 87–88), but appears to be simple. The abdomen is of normal length, rather tapering, and without signs of segmentation.

The egg-sacs are spindle-shaped and about 1·3 mm. long.

Lernaea barbicola Leigh-Sharpe

FIG. 89

1930 *Lernaea* (*Lernaeocera*) *barbicola* Leigh-Sharpe. *Parasitology* **22**: 334, text-figs. 1–6.

Mr. Leigh-Sharpe has kindly presented the holotype Reg. No. 1949.8.14.50 of this species mounted on a microscope slide to the Museum. It was from the tail of a species of *Barbus* from the Transvaal.

Unfortunately the arms of the anchor have been broken and it is no longer possible to see their arrangement.

Owing to the fact that the specimen is flattened on a slide the precise shape of the abdomen and pregenital prominence must remain uncertain; but I have made a camera lucida drawing (Fig. 89) which I hope is a little more accurate than Leigh-Sharpe's Fig. 2. Leigh-Sharpe's figures of the first and second pairs of legs are evidently not intended to show the precise setation of these limbs. All four pairs are visible in the preparation, and with the help of an immersion lens I have been able to make out the setation, which is precisely the same as that of *L. cyprinacea* (Table 1, p. 4).

Lernaea tuberosa sp. nov.

FIGS. 90–95

Holotype, Reg. No. 1949.8.14.51, and one paratype in the British Museum. Both specimens were from the body of the fish *Engraulicypris sardella* (Günther) from Lake Nyasa. The holotype was from the flank of a specimen collected by Dr. Christy in 1925, and the paratype was from the mid-ventral line of a fish in the Museum collection, Reg. No. 1908.10.27.24–33 collected by Captain Rhoades.

The length of both specimens is 11·5 mm. The positions of the five pairs of legs are 7·8, 18, 42, 72, and 91 per cent. in the holotype and 7·8, 18, 44, 76, and 93 per cent. of the body length from the anterior end in the paratype.

The total torsion in both specimens is 100° in a dextral sense. In the holotype this is the result of dextral torsions between legs 1 and 2 of 45°, between legs 2 and 3 of 40°, and between legs 3 and 4 of 15°. In the paratype the torsion is at first sinistral through 45° between legs 1 and 2, followed by dextral torsions of 105° between legs 2 and 3, 35° between legs 3 and 4, and about 5° behind legs 4.

The neck of both the specimens, that is the part of the body from the anchor to nearly the third legs, is covered with little peg-like processes which immediately distinguish this species from any other known at present, and which have suggested to me the trivial name *tuberosa*.

The anchor has four arms arranged as shown in Figs. 90 and 92–94; each bears a number of small finger-like processes. In spite of the apparent irregularity there is a distinct bilateral symmetry in the arrangement of the processes, and the two specimens are very similar to one another.

The pregenital prominence is distinct but single or only indistinctly bilobed. The abdomen is of normal length and tapering, with the segments not marked off from one another.

The egg-sacs of the holotype (Fig. 95) were small and rather shrunk in appearance.

KEY TO ADULT FEMALES

In the following key to the species of *Lernaea* those which I have seen are printed in **bold** type and those I know only from descriptions or figures are in *italics*.

The following species are omitted as I consider them to be synonyms:

L. bichiri (Kurtz, 1922) = **L. haplocephala** (Cunnington, 1914)
L. carassii Tidd, 1933 = **L. cyprinacea** Linnaeus, 1758
L. elegans Leigh-Sharpe, 1925 = **L. cyprinacea** Linnaeus, 1758
L. pectoralis (Kellicott, 1882) = *L. catostomi* (Krøyer, 1864)
L. temnocephala (Cunnington, 1914) = **L. barnimiana** (Hartmann, 1865)
L. tortua (Kellicott, 1881) = *L. catostomi* (Krøyer, 1864)
L. werneri (Kurtz, 1922) = *L. composita* Wilson, 1924

1. Neck with many peg-like protuberances . . . . **L. tuberosa** sp. nov.
Neck smooth 2
2. Anchor with four unbranched arms, confluent at their bases . . . 3
Anchor with some other arrangement of its arms 12
3. A localized swelling at least twice the width of the body present in the region of legs 2 4
Body not conspicuously swollen in region of legs 2 5
4. Abdomen of normal length, less than three times its breadth . . . **L. haplocephala** (Cunnington, 1914)
Abdomen very long, about a quarter of the total body length **L. longa** sp. nov.
5. Arms of anchor long and straight and in a plane roughly parallel to body axis 6
Arms not answering to this description 7
6. Pregenital prominence bilobed . . . . . **L. tilapiae** sp. nov.
Pregenital prominence with three lobes . *L. pomatoides* (Krøyer, 1864)
7. Anchor with dorsal arms curved and ventral arms straight **L. bagri** sp. nov.
Anchor not answering to this description 8
8. Abdomen short, little, if any, longer than pregenital prominence . . 9
Abdomen distinctly longer than pregenital prominence 10
9. Dorsal and ventral arms of anchor of about equal size . . . . *L. cruciata* (Lesueur, 1824)
Ventral arms much smaller than dorsal arms . *L. tenuis* (Wilson, 1916)
10. Pregenital prominence bilobed . . . . **L. lophiara** sp. nov.
Pregenital prominence simple 11
11. Arms not tapering, each with a kink near the end . . **L. palati** sp. nov.
Arms thick at base and tapering rapidly . . *L. composita* Wilson, 1924
12. Anchor of four simple flattened arms, an anterior pair in front of legs 1 and a posterior pair behind these legs . . *L. variabilis* (Wilson, 1916)
Anchor not answering to this description 13
13. Main bulk of anchor at right angles to the body like the cross-bar of a T, with the length of cross-bar at least a third of body length . . . 14
Anchor not answering to this description 17
14. Anchor with a median dorsal process bifid at the tip . . . . *L. dolabroides* Wilson, 1918

Anchor with no median dorsal process . . . 15

15. Lateral arms of anchor unbranched . . . *L. parasiluri* Yamaguti, 1939

Lateral arms of anchor each with a dorsal branch near the end . . . 16

16. Anchor with a small pair of ventral arms near middle line, body without a conspicuous constriction . . . **L. piscinae** sp. nov.

Anchor without ventral arms. Body with conspicuous constriction between legs 3 and legs 4 . . . **L. diceracephala** (Cunnington, 1914)

17. Anchor with six short, rounded protuberances, three on each side, a dorsal pair, a ventral pair, and also an anterior pair at the sides of the head . . . **L. bistricornis** sp. nov.

Anchor not answering to this description . . . 18

18. Anchor set at right angles to body by a ventral flexure by legs 2, arms lateral with bulbous branches. Posterior part of body much swollen . . . *L. insolens* Wilson, 1919

Not answering to this description . . . 19

19. Anchor with a median dorsal arm which may be branched, and lateral arms . . . 20

Anchor with arms in pairs, no median arm . . . 22

20. Dorsal arm twice bifid, posterior half of body behind legs 4 swollen and spindle-shaped . . . *L. lagenula* (Heller, 1865)

Dorsal arm unbranched, or branched only once . . . 21

21. Lateral arms simple . . . **L. barbicola** Leigh-Sharpe, 1930

Lateral arms branched at least once . . . *L. catostomi* (Krøyer, 1864)

22. Arms of both dorsal and ventral pairs bifid . . . *L. oryzophila* Monod, 1932

Either dorsal or ventral arms unbranched . . . 23

23. Ventral arms simple, dorsal arms branched . . . 24

Ventral arms branched, dorsal arms unbranched . . . 28

24. Ventral arms very short, hardly longer than breadth of head . . . **L. barnimiana** (Hartmann, 1865)

Ventral arms distinctly longer than breadth of head . . . 25

25. Ventral arms curved outwards, with a small swelling facing anteriorly about the middle of the curve . . . **L. barilii** sp. nov.

Ventral arms more or less straight, without a swelling . . . 26

26. Legs 2 as well as legs 1 between the bases of ventral arms. Abdomen in line with the body . . . *L. ranae* Stunkard & Cable, 1931

Legs 2 situated some distance behind the bases of ventral arms. Abdomen generally at an angle with body . . . 27

27. Arms not more than three times as long as they are broad. Dorsal arms nearly as short as ventral ones. Egg-sacs oval *L. esoscina* (Burmeister, 1835)

Arms slender and cylindrical in form. Dorsal arms distinctly longer than ventral. Egg-sacs spindle-shaped . . . **L. cyprinacea** Linnaeus, 1758

28. Branches of ventral arms unequal, main branch directed outwards and smaller one directed ventrally from it. Pregenital prominence bilobed . . . *L. phoxinacea* (Krøyer, 1864)

Ventral arms bifid at tip with resultant prongs equal and parallel. Pregenital prominence hemispherical . . . *L. senegali* Zimmermann, 1923

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THE CESTODES OF SEALS FROM THE ANTARCTIC

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THE CESTODES OF SEALS FROM THE ANTARCTIC

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SYNOPSIS

The present paper reviews and re-describes all known Pseudophyllidean Cestodes occurring in the five species of Antarctic Seals, namely, Weddell seal, Leopard seal, Crabeater seal, Elephant seal, and Ross seal. According to the literature, twelve species belonging to two genera have been previously recorded from these hosts.

The investigation of material collected by the British Graham Land Expedition, together with a comparative study of type-specimens collected by other Antarctic expeditions, leads to the conclusion that there are nine species of Pseudophyllidean Cestodes occurring in these hosts. These belong to four genera, two of which are new and of these, one represents a new species.

From the twelve species quoted in the literature, three are here placed in synonymy and one transferred to another genus.

MATERIAL AND METHODS

THE bulk of the material for this study was collected by the British Graham Land Expedition during 1934–1937. In addition, some samples gathered by the *Discovery* in 1925, 1928, and 1931, and by the 'Falkland Islands Dependencies Survey' in 1945, have been examined for comparative purposes. The material obtained by the British Graham Land Expedition comprises 33 lots from Weddell seals (*Leptonychotes weddelli*), 12 from Leopard seals (*Hydrurga leptonyx*), 6 from Crabeater seals (*Lobodon carcinophagus*), and 2 from Elephant seals (*Macrorhinus leoninus*). The *Discovery* material consists of 5 lots from Leopard seals and 1 from a Crabeater seal, and that of the 'Falkland Islands Dependencies Survey' of 2 lots only from Weddell seals. Thus the 61 batches of specimens investigated can be summarized as follows: 35 from Weddell seals, 17 from Leopard seals, 7 from Crabeater seals, and 2 from Elephant seals.

The British Graham Land Expedition's material was obtained from Graham Land (Debenham Is., Horseshoe I., Argentine Is., and Beascochea Bay), South Shetland (Deception I.), Palmer Archipelago (Melchoir I.), and South Georgia (Cooper Bay and Bay of Isles). The *Discovery* material was collected from South Orkneys (Coronation I.), South Georgia (Maivicken), and South Sandwich Is. The 'Falkland Islands Dependencies Survey' from Graham Land (Hut Cove, Hope Bay) and Palmer Archipelago (Port Lockroy, Wiencke I.). Preservation was in 4 per cent. formalin or, occasionally, in Bouin's Solution. The material comprises mainly portions of the gut with Cestodes attached to the walls, and individual specimens are, with a few exceptions, perfectly extended.

In addition to the new material, numerous collections from the same host-species were examined. These included the type-specimens described by Baird (1853), Shipley (1907), Rennie & Reid (1912), and Leiper & Atkinson (1914). The collection of Fuhrmann consisted of microscopical preparations of specimens, probably types, of Linstow (1892), of Railliet & Henry (1912), and material described by Fuhrmann (1920) himself. Some of the material in these collections is not in very good condition, the specimens mounted whole or as serial sections having partially lost their stains.

Over 1,200 slides of the present material have been made. Whole preparations have been stained with Mayer's paracarmine or alum carmine, and serial sections, $10\,\mu$ to $18\,\mu$ in thickness, have been double-stained with Ehrlich's haematoxylin and erythrosin.

I have great pleasure in expressing my heartiest thanks to Dr. H. A. Baylis, who kindly suggested this investigation and provided the necessary materials; to Dr. H. W. Parker, Keeper of the Department of Zoology, British Museum (Natural History); to Dr. M. Burton; and to Mr. S. Prudhoe for his valuable assistance. In addition, I wish to express my thanks to Professor J. G. Baer, Rector of the University of Neuchâtel, for his kindness in lending me the collection of slides left by the late Professor O. Fuhrmann, and to Dr. G. C. L. Bertram, of St. John's College, Cambridge, for information on the Graham Land Seals.

HISTORICAL

Our knowledge of Cestodes occurring in the Antarctic seals has been obtained almost exclusively from various Antarctic expeditions, including five British, one Australian, one French, and two German expeditions.

The first specimens were collected in 1839–1843 by Ross's Antarctic Expedition from a *Phoca* sp.—probably the Ross seal—and described by Baird (1853) as *Bothriocephalus antarcticus*. Further samples were collected from the Ross seal by the National Antarctic Expedition (*Discovery*) in 1901–1904 and described by Shipley (1907) under the name *Dibothriocephalus antarcticus*. Railliet & Henry (1912) studied this species from material collected from the Ross seal by the Second French Antarctic Expedition of Dr. J. Charcot (*Pourquoi Pas?*) 1908–1910 and described it as *Diphyllobothrium antarcticum*. Finally, Fuhrmann (1920)[1] re-examined the type-specimens and made the species the type of a new genus, *Glandicephalus*, characterized by the peculiar development of the musculature of the body, by the arrangement of the testes, and by the presence of gland-cells in the scolex. Johnston (1937) mentions the species as having been found in the Ross seal by the Australasian Expedition, 1911–1914.

Linstow (1892) described as *Bothriocephalus tectus* headless specimens from Elephant seals, collected at South Georgia by the German Expedition in 1882–1883. This was also recorded by Linstow in Shipley (1902) from the Ross seal, collected by the *Southern Cross* Expedition, 1898–1900, and by Johnston (1937) from the Elephant seal, in the collection of the Australasian Antarctic Expedition.

Diphyllobothrium quadratum (Linstow 1892) was collected for the first time from the Leopard seal by the German Expedition, 1882–1883, in South Georgia and in 1902–1904 by the Scottish National Antarctic Expedition (*Scotia*). It was re-described by Rennie & Reid (1912) as *Bothriocephalus coatsi*, from the same host. Railliet & Henry (1912) recorded this species as *Diphyllobothrium resimum*, collected by the Second French Antarctic Expedition. Later, Fuhrmann (1920) gave a description of *D. quadratum*, collected by the German South Pole Expedition, 1901–1903, and regarded *Bothriocephalus coatsi* (Rennie & Reid, 1912) and *Diphyllobothrium resimum* (Railliet & Henry, 1912) as synonyms of that name. Finally, Johnston (1937) gave a few further details of the species, based on material from the Leopard seal, collected by the Australasian Antarctic Expedition.

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[1] Fuhrmann's paper was published in 1920 (December) and not in 1921, as is often quoted.

Shipley (1907) described *Diphyllobothrium wilsoni* and *D. scotti*, the first being obtained from the Weddell seal and the Ross seal, and the second from the Ross seal, both having been collected by the National Antarctic Expedition, 1901–1904. They were re-described by Fuhrmann (1920) from the material obtained by the German South Pole Expedition (1901–1905) from the Ross seal and Leopard seal. They are also reported by Johnston (1937) from the Ross seal and the Weddell seal collected by the Australasian Antarctic Expedition.

Diphyllobothrium mobile (Rennie & Reid, 1912) from the Weddell seal and *D. scoticum* (Rennie & Reid, 1912) from the Leopard seal were collected for the first time by the Scottish National Antarctic Expedition in 1902–1904 and described by Rennie & Reid (1912) under the generic name *Dibothriocephalus*. Fuhrmann (1920) gives a full re-description of both these species from the Ross seal and the Weddell seal, and of *D. scoticum* from the Leopard seal, collected by the German South Pole Expedition in 1901–1903. Both species were studied by Johnston (1937) from material from the Weddell seal and the Leopard seal, collected by the Australasian Antarctic Expedition.

Diphyllobothrium perfoliatum Railliet & Henry, 1912, described also as *D. clavatum* in the same work, was collected for the first time by the Second French Antarctic Expedition from the Weddell seal. It was re-described by Leiper & Atkinson (1915) from material collected by the British Antarctic (*Terra Nova*) Expedition 1910 and by Fuhrmann (1920) from material collected by the German South Pole Expedition under the name *Dibothriocephalus perfoliatus*. In both cases the material was taken from the same host. Fuhrmann (1920) recognized *D. clavatum* as a synonym of *D. perfoliatum*. This Cestode is also mentioned by Johnston (1937) in a collection made by the Australasian Antarctic Expedition.

Diphyllobothrium rufum Leiper & Atkinson, 1914, collected by the *Terra Nova* Expedition in 1910, is considered by Johnston (1937) as 'a short-necked, precocious form of *D. perfoliatum*', found in the Weddel seal by the Australasian Antarctic Expedition.

The last two species, *Diphyllobothrium lashleyi* and *D. archeri*, were both described by Leiper & Atkinson (1914) from the Weddell seal gathered by the *Terra Nova* Expedition. The first of these species was re-described by Johnston (1937) from material from the same host-species collected by the Australasian Antarctic Expedition 1911–1914.

To sum up, 9 species have been described from the material collected by the British Antarctic Expeditions, 4 by the French, and 2 by the two German Expeditions.

The details of the result of each expedition are shown in Table No. 1.

TABLE NO. 1

A list of the Cestodes from Seals, collected by Antarctic Expeditions during the period 1839–1914

Expeditions	*Parasite*	*Host*
Ross's Antarctic Exp. 1839–1843	*Glandicephalus antarcticus* (Baird, 1853)	*Phoca* sp., probably Ross seal
Southern Cross Antarctic Exp. 1898–1900	*Diphyllobothrium tectum* (Linstow, 1892)	*Ommatophoca rossi*
National Antarctic Exp. (*Discovery*) 1901–1909	,, *scotti* (Shipley, 1907)	,,
	,, *wilsoni* (Shipley, 1907)	,,
	Glandicephalus antarcticus (Baird, 1853)	,,
Scottish National Antarctic Exp. (*Scotia*) 1902–1904	,, *antarcticus* (Baird, 1853)	,,
	Diphyllobothrium coatsi (Rennie & Reid, 1912)	*Hydrurga leptonyx*
	,, *mobile* (Rennie & Reid, 1912)	*Leptonychotes weddelli*
	,, *scoticum* (Rennie & Reid, 1912)	*Hydrurga leptonyx*
	Phyllobothrium sp. (larva) Rennie & Reid, 1912	*Leptonychotes weddelli*
British Antarctic Exp. (*Terra Nova*) 1910–1913	*Diphyllobothrium mobile* (Rennie & Reid, 1912)	,,
	,, *coatsi* (Rennie & Reid, 1912)	,,
	,, *perfoliatum* (Railliet & Henry, 1912)	,,
	,, *archeri* (Leiper & Atkinson, 1914)	,,
	,, *lashleyi* (Leiper & Atkinson, 1914)	,,
	,, *rufum* (Leiper & Atkinson, 1914)	,,
Australasian Antarctic Exp. 1911–1914	,, *perfoliatum* Railliet & Henry, 1912	,,
	,, *lashleyi* (Leiper & Atkinson, 1914)	,,
	,, *wilsoni* (Shipley, 1907)	,,
	,, *rufum* Leiper & Atkinson, 1914	,,
	,, *mobile* (Rennie & Reid, 1912)	,,
	,, *quadratum* (Linstow, 1892)	*Hydrurga leptonyx*
	,, *scoticum* (Rennie & Reid, 1912)	,,
	,, *scotti* (Shipley, 1907)	*Ommatophoca rossi*
	,, *wilsoni* (Shipley, 1907)	,,
	,, *mobile* (Rennie & Reid, 1912)	,,
	Glandicephalus antarcticus (Baird, 1853)	,,
	Diphyllobothrium tectum (Linstow, 1892)	*Mirounga leonina*
	Phyllobothrium sp. (larva)	,,
German Antarctic Exp., South Georgia, 1882–1883	*Diphyllobothrium tectum* (Linstow, 1892)	*Mirounga leonina*
	,, *quadratum* (Linstow, 1892)	*Hydrurga leptonyx*
German Antarctic Exp. (*Gauss*) 1901–1903	,, *perfoliatum* Railliet & Henry, 1912	*Leptonychotes weddelli*
	,, *quadratum* (Linstow, 1892)	*Hydrurga leptonyx*
	,, *wilsoni* (Shipley, 1907)	*Ommatophoca rossi*, *Hydrurga leptonyx*
	,, *mobile* (Rennie & Reid, 1912)	*Ommatophoca rossi*, *Leptonychotes weddelli*

TABLE NO. 1 (*continued*)

Expeditions	*Parasite*	*Host*
2nd French Antarctic Exp. (*Pourquoi Pas?*) 1908–1910, Dr. J. Charcot	*Diphyllobothrium resimum* Railliet & Henry, 1912	*Hydrurga leptonyx*
	,, *wilsoni* (Shipley, 1907)	*Leptonychotes weddelli*
	,, *perfoliatum* Railliet & Henry, 1912	,,
	,, *clavatum* Railliet & Henry, 1912	,,
	,, sp.? Railliet & Henry, 1912	*Ommatophoca rossi*
	Glandicephalus antarcticus (Baird, 1853)	,,
	Cestoda (unidentified)	*Lobodon carcinophagus*

The species enumerated above have been listed by Meggitt (1924) and Stunkard & Schoenborn (1936), though all these authors appear to have overlooked the work of Fuhrmann (1920), who reduced the number of species to twelve, apportioned between two genera, *Diphyllobothrium* and *Glandicephalus*.[1]

Wardle, McLeod, & Stewart (1947) have proposed a new classification of the genus *Diphyllobothrium*, but this appears to have been based mainly upon information obtained from the literature. Stunkard's (1948) criticism of the classification is fully subscribed to by the present writer.

DISCUSSION

After investigation of the new material it seems that the Pseudophyllidean Cestodes occurring in the Antarctic seals represent no more than 4 genera and 9 species namely:

1. *Diphyllobothrium lashleyi* (Leiper & Atkinson, 1914).
2. *D. mobile* (Rennie & Reid, 1912).
3. *D. quadratum* (Linstow, 1892).
4. *D. scoticum* (Rennie & Reid, 1912).
5. *D. wilsoni* (Shipley, 1907).
6. *Glandicephalus antarcticus* (Baird, 1853).
7. *G.* [*Diphyllobothrium*] *perfoliatus* (Railliet & Henry, 1912).
8. *Baylisia baylisi* gen. nov., spec. nov.
9. *Baylisiella tecta* (Linstow, 1892) gen. nov.

The details of their anatomical differences are given in Table No. 2.

Of the five species of *Diphyllobothrium* mentioned above, *D. lashleyi* alone possesses a well-developed distinct neck and the rudiments of genital organs at some distance behind it. In this it resembles both species of *Glandicephalus*. The rest of the species of *Diphyllobothrium* possess a very short indistinct neck, the presence of which has

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[1] In addition, unidentified Cestodes have been recorded from the Crabeater seal by Railliet & Henry (1912); and the larval stages of *Phyllobothrium* in the blubber of the Weddell seal by Rennie & Reid (1912) and Fuhrmann (1931). *Phyllobothrium delphini* (Bosc, 1802) Gervais, 1885, found by J. E. Hamilton in 1931 in the blubber of the Leopard seal at Falkland Islands is reported by Southwell & Walker (1936), and the larval stage of *Phyllobothrium* from Elephant seal by Johnston (1937).

Table No. 2

Comparative data of the species occurring in the Antarctic Seals, based on the writer's material

Parasite	*D. lashleyi*	*D. mobile*	*D. quadratum*	*D. scoticum*	*D. wilsoni*	*? D. spec.*	*G. perfoliatus*	*G. antarcticus*	*Baylisia, baylisi gen. nov. spec. nov.*	*Baylisiella tecta gen. nov.*
Body: length	19·5 cm.	14 mm.	12 cm.	130 cm.	5 cm.	7 mm.	20 cm.	10 cm.	126 cm.	32 cm.
width	3 mm.	510 μ	4·5 mm.	1·8 cm.	3 mm.	480 μ	7 mm.	7 mm.	8 mm.	2 cm.
Scolex: length	1·5 mm.	825 μ	1·8 mm.	3·5 mm.	825 μ	675 μ	3·5 mm.	3 mm.	900 μ	8 mm.
width	1·3 mm.	510 μ	1·4 mm.	2 mm.	450 μ	480 μ	2 mm.	2 mm.	1·3 mm.	5 mm.
Neck: length	450 μ–2·5 mm.	300 μ	1·5 mm.	495 μ	375 μ	absent	3 mm.	2·35 mm.	? absent	? absent
width	975 μ	495 μ	870 μ	825 μ	240 μ	. .	1 mm.	750 μ	. .	. .
Cirrus-sac: length	200 μ	112 μ	300 μ	231 μ	165 μ	?	264 μ	462 μ	750 μ	450 μ
width	93 μ	66 μ	60 μ	142 μ	99 μ	?	188 μ	231 μ	180 μ	150 μ
Vesicula seminalis: size	69 μ × 55 μ	83 μ × 50 μ	120 μ × 105 μ	285 μ × 180 μ	92 μ × 56 μ	?	132 μ × 148 μ	132 μ × 155 μ	198 μ × 99 μ	195 μ × 180 μ
Vesicula seminalis: wall thickness	17 μ	10 μ	17 μ	17 μ	20 μ	?	20 μ	10 μ	33 μ—50 μ	30 μ
Distribution of testes	single layer confluent anterior	single layer occur in anterior part of segment	single layer confluent anterior	single layer two separate fields	single layer confluent anterior	? ? ?	irregular single layer	scattered irregularly	single layer	2 or 3 layers
Approx. No. of testes	120	40	340	600	150	?	100	?	36	?
No. of testes on each side intransverse section	2–6	5	12–16	15	8	?	14	?	18	45
No. of testes in sagittal section	10–17	7	12–16	25	6–8	?	3–6	?	1	2–3
Testes: size	53 μ × 93 μ	66 μ × 99 μ	65 μ × 78 μ	150 μ × 210 μ	99 μ × 132 μ	?	172 μ × 93 μ	66 μ–116 μ × 59 μ–92 μ	116 μ × 40 μ	132 μ × 86 μ
Eggs: size	56 μ × 44 μ	60 μ × 43 μ	56 μ × 43 μ	79 μ × 56 μ	50 μ × 40 μ	?	66 μ × 50 μ	50 μ × 33 μ	66 μ × 46 μ	66 μ × 46 μ
Vitelline glands: size	33 μ × 50 μ	33 μ	50 μ × 33 μ	60 μ × 105 μ	66 μ × 50 μ	?	70 μ × 40 μ	40 μ × 50 μ	43 μ × 20 μ	66 μ × 26 μ
No. of cortical excretory vessels	28	?	34	20	14	?	16	30	76	108
Thickness of longitudinal muscle-layer	20 μ	4 μ	33 μ	150 μ	17 μ	?	300 μ	? 450 μ	450 μ	555 μ
Host	Weddell seal	Weddell seal	Leopard seal	Leopard seal	Leopard seal, Weddell seal	Crabeater seal	Weddell seal	Ross seal	Crabeater seal	Elephant seal

PLATE 10, FIGS. 1–9

ABBREVIATIONS USED: *c.*, cirrus; *c.b.*, 'calcareous body'; *c.g.*, cephalic glands; *c.s.*, cirrus-sac; *d.v.m.*, dorso-ventral musculature; *ex*, excretory system; *g*, glands; *g.p.*, genital papillae; *l.m.*, longitudinal musculature; *m*, muscles; *n*, nerve; *o*, ovary; *oc.*, oocapt; *r.s.*, receptaculum seminis; *s.g.*, shell-gland; *t.*, testis; *t.m.*, transverse musculature; *u.*, uterus; *v.*, vagina; *v.d.*, vas deferens; *v.g.*, vitelline glands; *v.s.*, vesicula seminalis; *y.r.*, yolk reservoir.

FIG. 1. *Diphyllobothrium lashleyi* from Weddell seal. Sagittal section of cirrus-sac.

FIG. 2. *D. mobile* from Weddell seal. Sagittal section of cirrus-sac.

FIG. 3. *D. quadratum* from Leopard seal. Sagittal section of cirrus-sac.

FIG. 4. *D. scoticum* from Leopard seal. Sagittal section showing glandular cells.

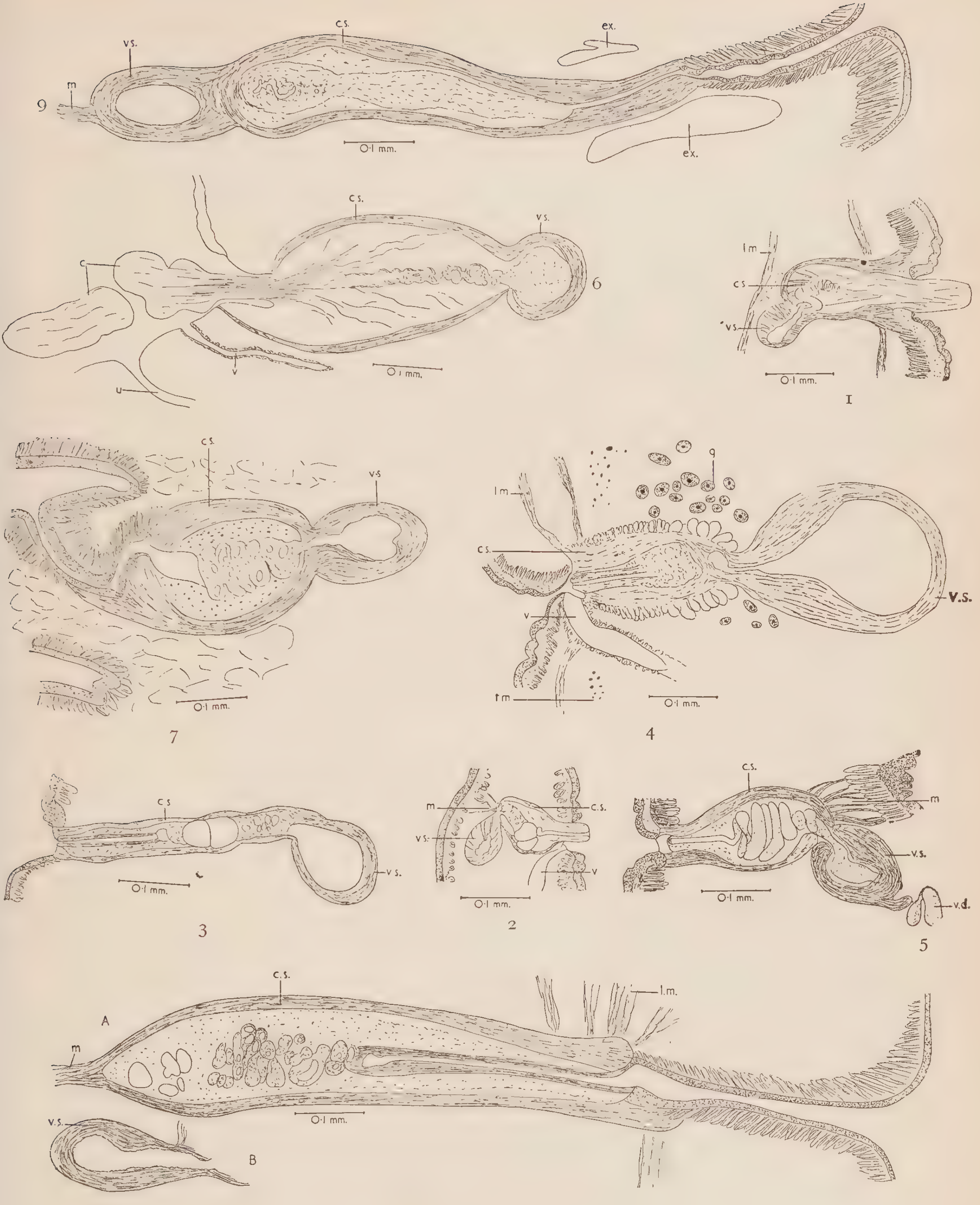
FIG. 5. *D. wilsoni* from Weddell seal. Sagittal section of cirrus-sac, with coiled cirrus showing muscle-fibres attached to the dorsal wall of the segment.

FIG. 6. *Glandicephalus antarcticus* from Ross seal. Sagittal section of cirrus-sac.

FIG. 7. *Glandicephalus perfoliatus* from Weddell seal. Sagittal section of cirrus-sac.

FIG. 8. *Baylisia baylisi* from Crabeater seal. (*a*) Sagittal section of cirrus-sac. (*b*) Vesicula seminalis in the same section.

FIG. 9. *Baylisiella tecta* from Elephant seal. Sagittal section of cirrus-sac.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m
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ex.
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2
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m
v.s.
v.d.
0·1 mm.
5
c.s.
l.m.
A
m
0·1 mm.
v.s.
B
8

FIGS. 1–9

often been questioned by previous authors. The neck of these species of *Diphyllobothrium* is extremely short, no more than a continuation of the scolex, and the rudiments of the genital organs occur in the immediate vicinity of the neck, usually in the second segment.

Diphyllobothrium perfoliatum Railliet & Henry, 1912, has been transferred by the present writer to the genus *Glandicephalus* Fuhrmann (1920), owing to the peculiar structure of its longitudinal musculature, which is almost identical with the musculature in *G. antarcticus*. In addition, there is a similar, though not identical distribution of the testes. Both these features were stressed by Fuhrmann (1920) in his original diagnosis. Both species also possess imbricated proglottids, though these are less developed in *G. antarcticus*. The name *Glandicephalus* is not very appropriate, as cephalic glands may also occur in species of *Diphyllobothrium*. On the other hand, cephalic glands have not been found in the scolex of *Glandicephalus perfoliatus* stained with Ehrlich's haematoxylin. Nevertheless, on anatomical grounds it finds its closest affinities in *G. antarcticus*.

It would seem that the cirrus-sac of the male genital apparatus, examined in sagittal section, and the longitudinal musculature, seen in transverse section, give the best means of determining species. This is true not only for *Diphyllobothrium* but for the other forms dealt with here. Earlier writers paid much more attention to the size of the body, shape and size of the scolex and of the neck, and the number, shape, and size of the segments.

More attention was paid to the female genital system than to that of the male. Such features as the shape and number of the uterine coils, the size and shape of the ovary, and the size of the eggs and vitelline glands were considered significant, as well as the position of the external openings of the genital apparatus. In some cases the presence of cephalic glands in the scolex was accepted as a generic difference (Nybelin, 1931).

There is nothing more deceptive in the species of *Diphyllobothrium* than the size of the body, its length and width. For example, *D. lashleyi* may vary from 4·5 cm. to 19·5 cm. in length in the adult. Greater differences in length, observed in new material, have been recorded for *D. scoticum*, which varies from 13 cm. to 130 cm., and for *D. wilsoni* from 10 mm. to 50 mm. The number of segments also is variable.

The scolex is also of a doubtful value, as its size and shape depends much on the fixatives used. Only in a few cases does it present distinct morphological differences.

The presence of cephalic glands in the scolex has been demonstrated in *D. lashleyi*, *D. mobile*, and *D. quadratum* by using Ehrlich's haematoxylin. They were also found to occur in the scolex of *Glandicephalus antarcticus* by Fuhrmann (1920) and by Nybelin (1931) in *Adenocephalus*. This means that they occur in widely different genera. This feature cannot therefore be used for generic distinction. Only in *D. scoticum*, *Baylisia baylisi*, and *Baylisiella tecta* does the scolex show characteristic differences as compared with the other species mentioned in this paper.

The neck is extremely variable in size and possesses a diagnostic value only when it constitutes a well-marked feature. As previously stated, a neck is present in *D. lasheyi* and is also fairly well developed in *Glandicephalus antarcticus* and *G. perfoliatus*. In *D. lashleyi*, however, it is so contracted in some cases that the specimen gives an impression of being without a neck and, as a consequence, of belonging to another species.

Owing to this variation of the neck Leiper & Atkinson (1914) described *Diphyllobothrium rufum* as a separate species, but it now appears to be a synonym of *G. perfoliatus*. *D. rufum* was distinguished by the absence of a neck, an effect which might be caused by contraction, and by 'notches' in the imbricated portions of the segments.

The female genital apparatus is of little use for purposes of identification. The uterus is a more or less irregular sac, filled with eggs, with the opening, in the majority of cases, irregularly alternate. Only in *D. scoticum* is the terminal part of the uterus modified to form a characteristic 'pocket' lined with villous tissues.

The ovary also varies considerably in shape and size, even in the same strobila. In *D. lashleyi*, for instance, the ovaries in squarish segments are entirely different in shape to those in elongate segments.

The sizes of eggs, given in Table No. 2, do not show any remarkable difference, except in *D. scoticum*, but this differs from other species in many other anatomical details, much more distinct than the size of the eggs.

The vitelline glands, forming a continuous field along the strobila and covering internal structures in all species, have a characteristic form only in *D. mobile*, where this continuous field is interrupted by the transverse segmentation of the body.

The excretory system, proposed as a criterion for identification of some of the Cestodes from seals by Zschokke (1903), is also uncertain since it undergoes changes during the fixation and the consequent contraction of the body.

An excretory system occurs in the cortical and medullary parenchyma in the Cestodes of the Antarctic seals belonging to the species of *Diphyllobothrium*, although in the present material of *D. mobile* no excretory system has been detected. In *Baylisia baylisi* and *Baylisiella tecta* the system seems to be present only in the cortical parenchyma, where it reaches a high degree of development.

The most essential specific differences occur in the male genital apparatus and in the development of the longitudinal musculature, as well as in the relation of this musculature to the transverse and the dorso-ventral muscles. The cirrus-sac, examined in sagittal section, differs specifically in shape and size. Plate 10, figs. 1–9, shows these morphological differences exhibited by the various species enumerated in this paper. The size, shape, and position of the vesicula seminalis in relation to the cirrus-sac may be very variable in some species, but in others it is sufficiently constant to have a taxonomic value. The testes, which in the species of *Diphyllobothrium* occur in two lateral fields, are arranged in a single layer and are usually confluent in the anterior part of the segment. In *D. mobile*, however, they are arranged in one field in the anterior part of the segment, and in *D. scoticum* they form two separate fields, one at each side of the segment. The two species of *Glandicephalus* have testes scattered more or less irregularly. The same arrangement occurs in *Baylisiella tecta*. In the last case the precise number of testes occurring in the segment is difficult to determine, the more so as they are arranged in several irregular layers. The number of testes per segment has not, therefore, any value as a taxonomic criterion in *Baylisiella*. The numbers of the testes counted in transverse and sagittal

PLATE 11, FIGS. 10–18

(*For list of abbreviations see Plate* 10)

Fig. 10. *Diphyllobothrium lashleyi* from Weddell seal. Transverse section of muscular system.

Fig. 11. *D. mobile* from Weddell seal. Transverse section of muscular system.

Fig. 12. *D. quadratum* from Leopard seal. Transverse section of muscular system.

Fig. 13. *D. scoticum* from Leopard seal. Transverse section of muscular system.

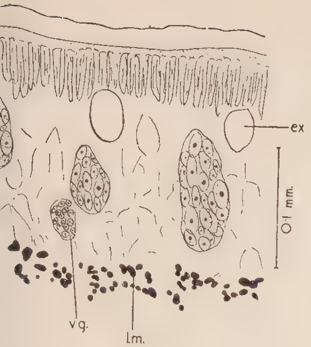
Fig. 14. *D. wilsoni* from Weddell seal. Transverse section of muscular system.

Fig. 15. *Glandicephalus antarcticus* from Ross seal. Transverse section of muscular system, showing network formed by transverse and dorsoventral musculature, enclosing in its 'meshes' the longitudinal muscle-fibres.

Fig. 16. *Glandicephalus perfoliatus* from Weddell seal. Transverse section of muscular system, showing similar structure as in *G. antarcticus.* Upper part of cortical parenchyma has not been depicted.

Fig. 17. *Baylisia baylisi* from Crabeater seal. Transverse section of muscular system.

Fig. 18. *Baylisiella tecta* from Elephant seal. Transverse section of muscular system, showing its peculiar structure and the powerfully developed cortical excretory system. Only a part of cortical parenchyma and vitelline glands have been drawn.



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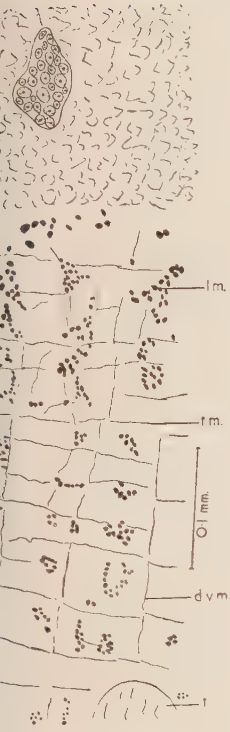

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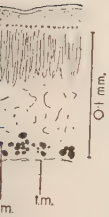

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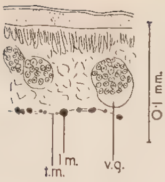

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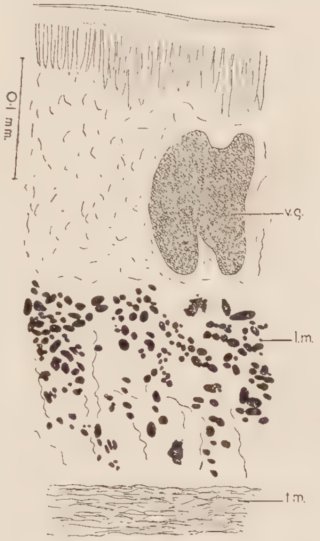

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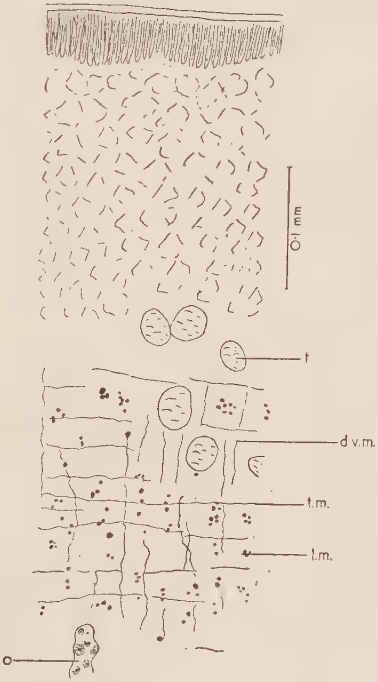

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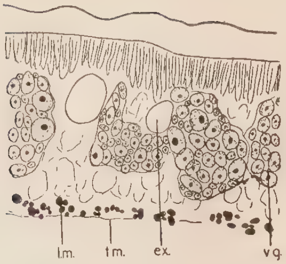

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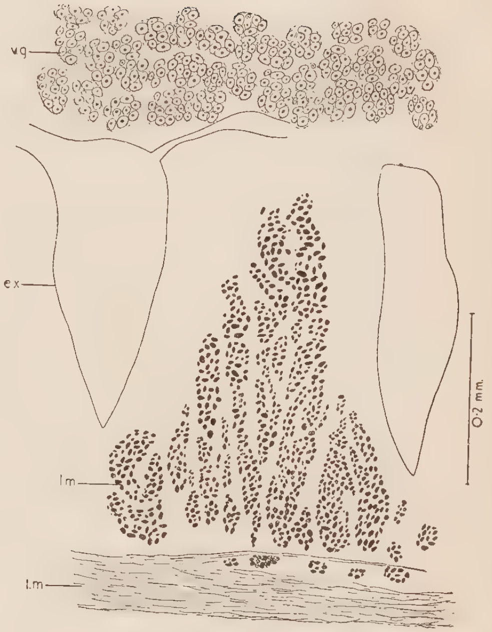

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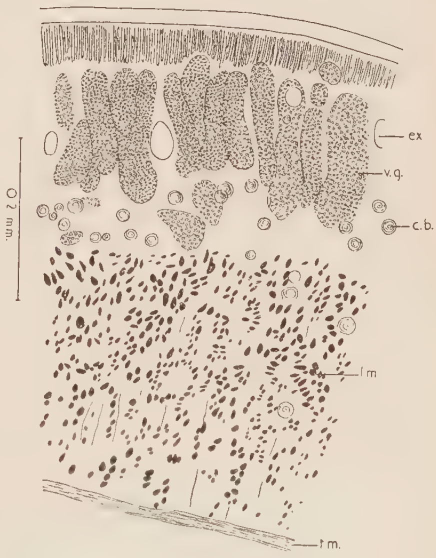

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Figs. 10–18

sections, shown in the Table No. 2, are more constant for a given species, although the numbers of the testes seen in the sagittal plane may differ in the same individual according to the shape of the segment. This was discovered in *D. lasheyi*, which possesses two types of gravid segments: squarish and elongate. In one of the squarish segments there are about 10, in the sagittal plane, and in the elongate segments 17 testes. It seems that the size of the segment has no effect on the number of testes. In *Diphyllobothrium scoticum*, for example, where the variations in size of the segments are enormous, but the shape is the same, the number of testes in the sagittal plane of the small and the large segments is the same.

The longitudinal muscular coat, examined in transverse section, and its relation to the transverse and dorso-ventral muscles also gives very clear specific differentiation. The thickness of the longitudinal muscular coat and the arrangements of the muscular bundles are characteristic for each species. The numerical differences in the thickness of the muscular coat have been given in Table No. 2. The morphological differences are shown in Plate 11, figs. 10–18.

Examination of the musculature has been made in transverse sections of the hinder part of the segment, between the ovary and the first uterine coils. This part of the segment is not affected by such factors as the pressure of the uterus filled with eggs or histological changes of the ovary, which may interfere with or alter the position of the muscles. The relation of the transverse musculature to the longitudinal is also different in many cases (Pl. 11, figs. 10–18). The transverse musculature in *D. quadratum* is so feebly developed that the separate muscle-fibres might be overlooked in the serial sections. A similar feeble development of the transverse musculature occurs in *D. mobile*, *D. wilsoni*, and *D. lasheyi*, although in these the single muscle-fibres are much more distinct. In the rest of the species, namely, *D. scoticum*, *Baylisia baylisi*, and *Baylisiella tecta*, the transverse and longitudinal muscular coats are very powerfully developed. Moreover, the longitudinal muscles in *B. tecta* are very characteristic.

In *Glandicephalus antarcticus* and *Diphyllobothrium perfoliatum* the transverse and the dorso-ventral muscular system forms a kind of network containing the longitudinal muscular fibres in its meshes. Because of the similarities in the musculature of these species, together with a few more points of resemblance in their anatomy, *D. perfoliatum* has here been transferred to the genus *Glandicephalus* Fuhrmann (1920).

SYSTEMATIC NOTES

1. ***DIPHYLLOBOTHRIUM*** Cobbold (1858)

This genus is represented in the Antarctic seals by five species.

Diphyllobothrium lashleyi (Leiper & Atkinson, 1914)

[PL. 10, FIG. 1; PL. 11, FIG. 10; PL. 12, FIGS. 19–24]

Dibothriocephalus lashleyi Leiper & Atkinson, 1914.
Diphyllobothrium lashleyi Meggitt, 1924.
Dibothriocephalus archeri Leiper & Atkinson, 1914.

Diphyllobothrium archeri Meggitt, 1924.
Host: Weddell seal (*Leptonychotes weddelli*).
Locality: Debenham Islands; Deception Island; Melchior Archipelago.

This tapeworm has been found in large numbers in the intestine of seven Weddell seals. Leiper & Atkinson (1914) give its maximum length as 4 cm. and Johnston (1937) 22 mm. The variation in the length of the body as shown by the new material is much greater, from 4 cm. to 19·5 cm. The width is constant at about 3 mm.

The segments are not overlapping and are variable in shape. Those in front are squarish with curved lateral edges; those in the hinder part of the body become elongate. Both kinds of segment may be fully gravid. The size of the first squarish segment bearing eggs is, in mounted specimens, 1 mm. in length and 2 mm. in width. The elongate segments are about 7 mm. in length and 3 mm. in width. The terminal segment is usually slightly tapering and rounded at the end.

The surface of the body in preserved specimens bears transverse furrows, caused probably by the fixative.

The parenchyma is very loose and delicate, and mounted specimens are very transparent, showing the internal structure.

The neck is well developed in fully extended specimens and marked off from the rest of the body. In specimens slightly contracted it is not distinguishable. As a consequence it varies from 450 μ to 2·5 mm. in length.

The scolex, sharply marked off from the body, is also variable in shape; it is globular or oval and possesses internal grandular cells, though this was not previously known. The size of the scolex in mounted specimens is from 1 mm. to 1·5 mm. in length and 0·9 mm. to 1·3 mm. in width.

The genital openings are median, except the uterine pores which alternate in an irregular manner. The genital atrium is surrounded with strongly developed papillae.

In optical view in whole preparations the cirrus-sac appears to be spherical. In sagittal section its length is about 200 μ and the height (antero-posterior) about 93 μ. The cirrus of the specimens examined was usually protruded. The cuticle of the area around the male genital pore is provided with radiating ridges. In the segments examined the vesicula seminalis is in a straight line with the cirrus-sac or inclined to it at a slight angle, and in sagittal section it is about 69 μ long and 55 μ wide, with walls about 17 μ thick.

The testes are arranged in a single layer, about 60 on each side of the segment. They are about 53 μ to 93 μ in diameter. In the squarish segments there are, in transverse section, 2–6 testes each side, and, in sagittal section, 10 testes. In the elongate segments the number of testes in transverse section is 3 on each side and in sagittal, 15–17.

The uterine opening is situated about 116 μ from the cirrus-sac. The uterus forms compact, though not very distinct, coils, and in the elongate segments is club-shaped, tapering posteriorly, and is irregular in outline. In the squarish proglottids the uterus is confluent with the cirrus-sac, reaching its level and alternating with it to its right or left side rather irregularly.

The vagina and the male pore open side by side into the common genital atrium.

The ovary has a compact or reticular structure. It differs with the shape of the

PLATE 12, FIGS. 19–24

(*For list of abbreviations see Plate* 10)

Diphyllobothrium lashleyi from Weddell seal

FIG. 19. Scolex.

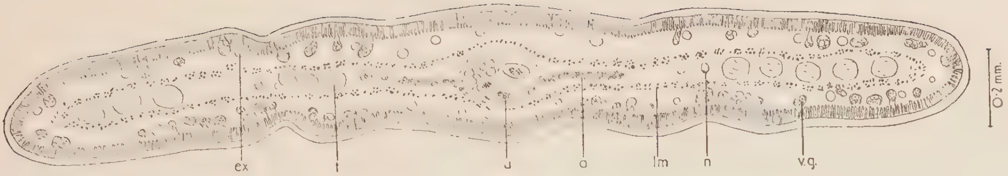
FIG. 20. Gravid, not fully shaped segment.

FIG. 21. Gravid, fully developed elongate segment.

FIG. 22. Transverse section of segment.

FIG. 23. Sagittal section of segment.

FIG. 24. Sagittal section of scolex, showing cephalic glands.



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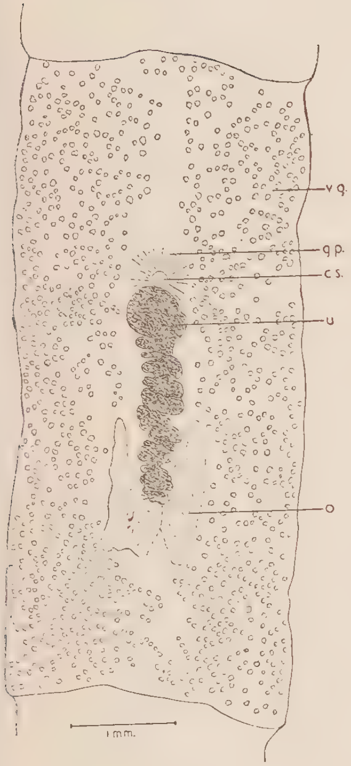

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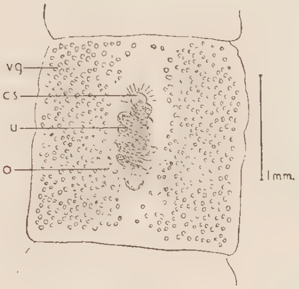

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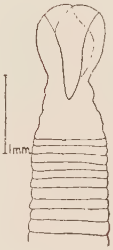

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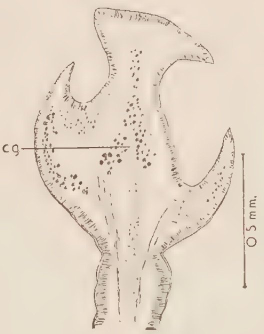

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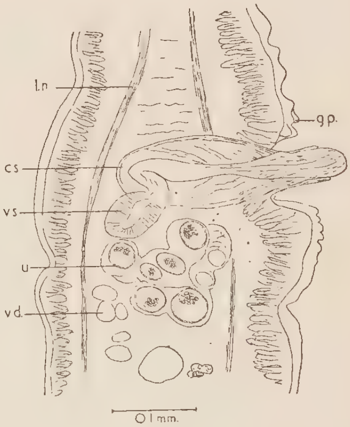

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FIGS. 19–24

segment. In the squarish segment it is more compactly built and oval in shape; in the elongate segments its structure is reticular and more diffuse.

The eggs are 53–56 μ × 40–44 μ.

The vitelline glands, composed of large cells, are irregular with rounded lobes. They are sometimes slightly confluent in the anterior parts of the segment and much more so in the posterior region. There is an area free from vitelline glands around the genital complex. The products of the glands are collected in special ducts running through the cortical parenchyma. It seems that there occur additional collectors, transferring the yolk to the main yolk reservoir which is situated in the central part of the segment below the uterus. The reservoir is filled with large yolk cells, olive-greenish in colour. The size of the vitelline glands is 33 μ to 50 μ in diameter.

The longitudinal muscles form a coat, 20 μ thick in transverse section, composed of irregularly distributed bundles. The dorso-ventral musculature is feebly developed.

The excretory system consists of two main stems in the medullary parenchyma and some 28 vessels occurring in the cortical part of the segment, as seen in transverse section.

Leiper & Atkinson (1914) described *D. archeri* from the Weddell seal as a separate species. Comparison of the type specimens of *D. archeri* and *D. lashleyi* with the new material leads to the belief that *D. archeri* is a synonym of *D. lashleyi*. Both authors dealt with specimens not fully developed and having squarish segments, but the anatomical features of the two species, as seen in serial sections of the type specimens, are closely similar. The structure of the longitudinal muscles, cirrus-sac, and the number and arrangements of testes are identical.

Diphyllobothrium mobile (Rennie & Reid, 1912)

[Pl. 10, fig. 2; Pl. 11, fig. 11; Pl. 13, figs. 25–31]

Dibothriocephalus mobilis Rennie & Reid, 1912.
Diphyllobothrium mobile Meggitt, 1924.
Diphyllobothrium wilsoni Railliet & Henry, 1912.
Dibothriocephalus coatsi Leiper & Atkinson, 1914 (*nec* Rennie & Reid, 1912).
Host: Weddell seal (*Leptonychotes weddelli*).
Locality: Debenham Islands.

This species is recorded from seven Weddell seals, twice in company with *Glandicephalus perfoliatus*. The infection was in most cases a mass infection.

The length of the body of the specimens examined varied from 2·3 mm. to 14 mm., and the width from 345 μ to 510 μ.

The strobila is composed of about 14 segments, which in the anterior part of the strobila are wider than they are long. The terminal segment is usually oval.[1]

The scolex is 675 μ–825 μ in length and 345 μ–510 μ in width. Longitudinal serial sections show that it contains glandular tissue.

The neck is little more than an unsegmented part of the scolex, 300 μ in length and 495 μ in width.

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[1] Beside the normally-developed segments, one abnormal strobila has been found in the writer's material. In it, the segments are split into two parts. The left-hand portion forms a kind of cul-de-sac and possesses testes and vitelline glands. The right part, which is a continuation of the strobila, contains eggs. (Pl. 13, fig. 25.)

The genital rudiments occur in the immediate vicinity of the scolex. The specimens of 2·3 mm. in length have distinctly visible genital anlagen and well-separated testes.

The length of the cirrus-sac, measured in sagittal section, is about 112 μ and its height 66 μ. Some very thin muscular fibres attach the proximal part of the cirrus-sac to the dorsal wall of the segment.

The vesicula seminalis measures, in sagittal section, about 83 μ by 15 μ; its walls are about 10 μ thick and it is in a straight line with the cirrus-sac.

The testes seem to occur only in the anterior part of the segment and are from 22 to 44 in number. There are 5 testes on each side in the transverse, and 6 to 7 in the sagittal, sections of the segment. They are 66 μ to 99 μ in diameter.

The uterine openings alternate irregularly. The uterus forms a compact mass of coils. In the anterior part of the body it is situated below the cirrus-sac, and in segments in the hinder part of the strobila its coils surround the male copulatory organ.

The vagina opens into the common genital opening in the vicinity of the male opening.

The ovary forms two more or less elongate-oval wings.

The eggs measure 56–60 μ by 40–43 μ.

The vitelline glands, about 33 μ in diameter, are arranged in two separate lateral fields in each segment. A narrow transverse space free of vitelline glands is distinctly visible in the anterior part of the segment in whole preparations as well as in serial sections.

The longitudinal musculature is very feebly developed. It forms a coat about 4 μ thick, composed of single, barely visible, fibres.

The excretory system has not been detected, probably owing to contraction due to the fixative.

Diphyllobothrium quadratum (Linstow, 1892)

[PL. 10, FIG. 3; PL. 11, FIG. 12; PL. 14, FIGS. 32–36]

Bothriocephalus quadratus Linstow, 1892.
Dibothriocephalus quadratus Zschokke, 1903.
Diphyllobothrium quadratum Railliet & Henry, 1912.
Cordicephalus quadratus Ward, McLeod & Stewart, 1947.
Dibothriocephalus coatsi Rennie & Reid, 1912.
Bothriocephalus coatsi Fuhrmann, 1920.
Dibothriocephalus resimum Railliet & Henry, 1912.

Host: Leopard seal (*Hydrurga leptonyx*).

Locality: Galindez Island, Argentine Islands; Debenham Islands; Horseshoe Island and Sandefjord Harbour, Coronation Island.

This species is recorded from five Leopard seals, some of which were very heavily infested.

The length of the body is from 4 to 12 cm. and the width about 4·5 mm. The specimens obtained from the mass infested hosts averaged about 4 cm. in length. In horizontal serial sections the lateral margins of the body seem to have a villous character.

The segments are square, about 1·5 mm. long and 1 to 4·5 mm. in width. Their lateral edges in the hinder part of the strobila are slightly convex. The terminal segment is oval.

PLATE 13, FIGS. 25–31

(*For list of abbreviations see Plate* 10)

Diphyllobothrium mobile from Weddell seal

FIG. 25. Malformation of strobila.

FIG. 26. Young specimen with genital anlagen.

FIG. 27 (*a*). Sagittal section of scolex, showing glandular tissue. (*b*) Glandular cells enlarged.

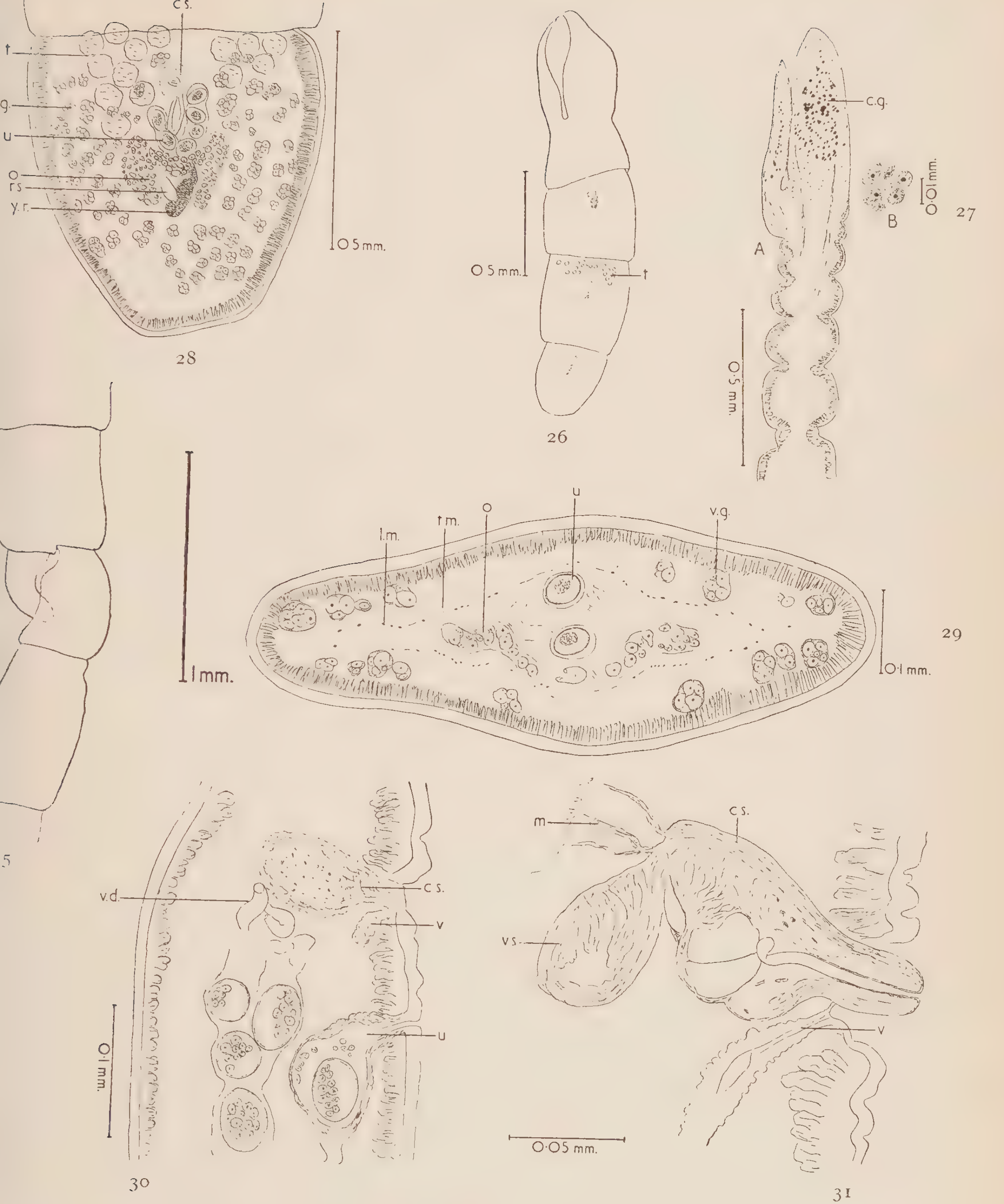
FIG. 28. Terminal gravid segment.

FIG. 29. Transverse section of segment.

FIG. 30. Sagittal section of segment, showing terminal part of uterus.

FIG. 31. Sagittal section of male and female openings.

PLATE 13



Figs. 25–31

PLATE 14, FIGS. 32–36

(*For list of abbreviations see Plate* 10)

Diphyllobothrium quadratum from Leopard seal

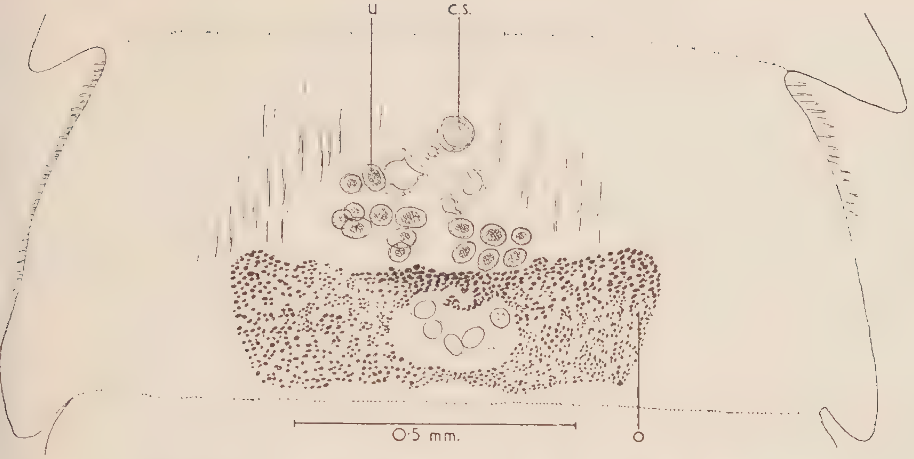
FIG. 32. Scolex.

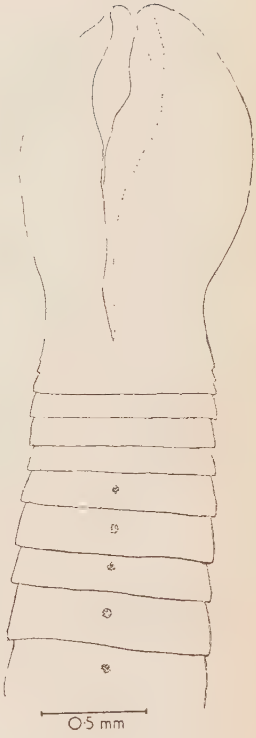
FIG. 33. Gravid segment.

FIG. 34. Horizontal section of segment, showing structure of ovary.

FIG. 35. Transverse section of segment.

FIG. 36. Sagittal section of segment.





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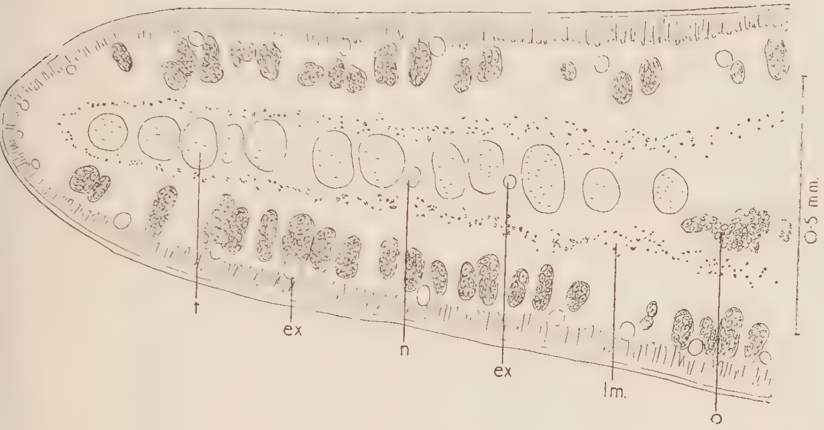

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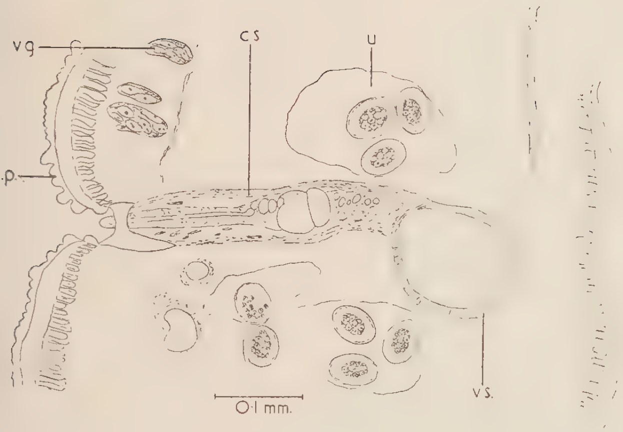

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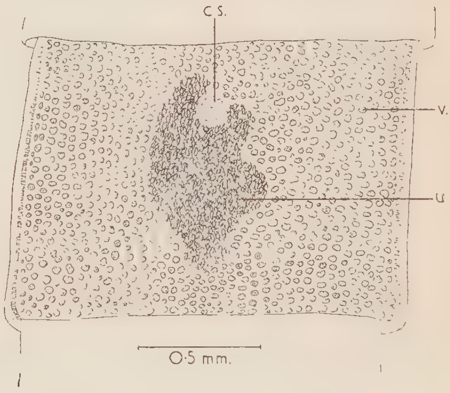

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Figs. 32–36

The scolex of the mounted specimens is 1 to 1·8 mm. in length and 960 μ to 1·4 mm. in width, more or less ovoid in shape and possesses internal glandular tissue.

The neck although short is recognizable and measures from about 450 μ to 1·5 mm. in length and from 587 to 870 μ in width.

The genital rudiments occur in the segment next behind the neck. In whole preparations the cirrus-sac appears to be spherical; in sagittal section its length is about 300 μ and height 60 μ.

The vesicula seminalis is connected with the cirrus-sac almost along the same axis and is 120 μ in length and 105 μ in width. The walls are about 17 μ thick. The almost spherical shape of the organ is sometimes rendered more or less irregular, probably by the fixative used.

There are about 340 testes in each segment, 170 on each side and confluent in its anterior part. They are arranged in a single layer, though this is not very regular in some cases, probably owing to contraction. This was observed in the small 4 cm. long specimens, where some of the testes were arranged in two planes. There are 12 to 16 testes on each side in the transverse, and 12 to 16 in the sagittal, section. They are not very regular in shape and measure about 65 μ by 78 μ.

The vas deferens is situated dorsally in the segment and forms numerous coils.

The uterine openings alternate irregularly. In the hinder region of the strobila the uterus is converted into an irregular sac filled with eggs. The anterior part of the uterus surrounds the cirrus-sac which, in the gravid posterior segments, is hardly visible.

The ovary forms two wings, which surround the lower coils of the uterus. The thin-shelled and operculate eggs are 56 μ by 43 μ.

The vitelline glands are very numerous, thickly arranged, irregularly lobed, and measure 50 μ by 33 μ. They obscure all other organs of the genital complex except the uterus and the cirrus-sac.

The longitudinal muscles, not very well developed, form a coat about 33 μ thick. They are composed of single bundles of fibres.

The transverse and dorso-ventral musculature is composed of single fibres running in these two planes.

The excretory system comprises two main vessels in the medullary parenchyma and about 34 trunks in the cortical part of the segment in transverse section.

Diphyllobothrium scoticum (Rennie & Reid, 1912)

[PL. 10, FIG. 4; PL. 11, FIG. 13; PL. 15, FIGS. 37–43]

Dibothriocephalus scoticus Rennie & Reid, 1912.
Diphyllobothrium scoticum Meggitt, 1924.
Dibothriocephalus pygoscelis Rennie & Reid, 1912.
Host: Leopard seal (*Hydrurga leptonyx*).[1]
Locality: Debenham Islands.

This species has been found in four Leopard seals. The number of worms per host varied from 2 to 14.

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[1] Baylis (in Hamilton, 1934) assigned to *Diphyllobothrium scoticum* some Cestodes from the intestine of *Otaria byronia*, but the identification was only provisional and has not yet been confirmed.

The body is much longer than recorded by Fuhrmann (1920) and Johnston (1937) and ranges in the specimens examined from 52 cm. to 130 cm., with a corresponding width of 0·5 cm. to 1·8 cm. The elliptical scolex is about 3·5 mm. in length and 2 mm. in width. No glandular tissue has been found in this organ.

The neck is about 495 μ in length and 825 μ in width. The figures for scolex and neck have been taken from a mounted specimen 52 cm. long.

The segments are shorter than wide and have convex lateral edges. They are tapering in the posterior part of the body, and the terminal segment in small specimens is ovoid. The posterior lateral edge of the segment seems to have a semicircular thickening (Pl. 15, fig. 43). The gravid segments are 5 to 8 mm. in length and 1·5 cm. to 1·8 cm. in width.

The genital rudiments occur in the first segment behind the neck. The male genital openings are surrounded by numerous papillae, radially arranged, and are sometimes bordered with a semi-lunar furrow.

In sagittal section the cirrus-sac measures about 231 μ in length and 142 μ in height. In the vicinity of the cirrus-sac, plainly visible in the sagittal section, occur spherical cells, probably of a glandular character.

The vesicula seminalis is situated in the same main axis, as a continuation of the cirrus-sac. It is about 285 μ in length and 180 μ in width, with walls about 17 μ thick.

The vas deferens runs dorsally in numerous coils.

There are about 600 testes, disposed in two separate fields about 300 on each side, arranged in a single layer and measure about 150–210 μ by 150 μ; they are not confluent in the anterior part of the segment. The number of testes in sagittal section amounts to 25. It seems that there is no difference in the number of testes in sagittal section as between the large and the small gravid specimens. The number of testes counted in transverse section amounts to 14–15 on each side.

The uterine openings alternate irregularly, and are situated in a transverse groove. The terminal part of the uterus is modified to form a thick-walled pocket, lined with a villous tissue. This modification of the terminal uterine duct is typical for the species. The uterus is not of a 'rosette' type but forms spiral coils, more or less distinct, 5–12 in number on each side.

The ovary is reticular and irregularly palm-shaped. The eggs, some provided with a boss, are 76–79 μ by 56 μ.

The vitelline glands, composed of small cells, are fairly large, about 60–105 μ in diameter. They are confluent in the anterior part of the segment, leaving a free area around the genital opening.

The longitudinal, transverse, and dorso-ventral musculature is very well developed. The longitudinal muscles form a coat 150 μ thick measured in transverse section, composed of numerous fibres, collected in not very distinct bundles. They are thickly arranged in the upper parts of the muscular coat, gradually becoming less dense towards the middle of the segment.

The excretory system consists of 2, not always distinctly visible, trunks in the medullary parenchyma and about 20 in the cortical parenchyma. It is, however, not always possible to be sure of the number of cortical excretory vessels as the vessels may contract as a result of fixation and may not be distinct in serial sections.

PLATE 15, FIGS. 37–43

(*For list of abbreviations see Plate* 10)

Diphyllobothrium scoticum from Leopard seal

FIG. 37. Gravid segment of small specimen.

FIG. 38. Modification of terminal part of uterus, seen in transverse section.

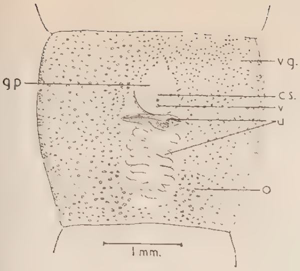
FIG. 39. Scolex.

FIG. 40. Gravid segment of large specimen. Part of cortical parenchyma has been removed, showing distribution of testes and terminal modification of uterus.

FIG. 41. Transverse section of segment.

FIG. 42. Sagittal section of segment with male and female openings.

FIG. 43. Outline of posterior edges of segment, in sagittal section.



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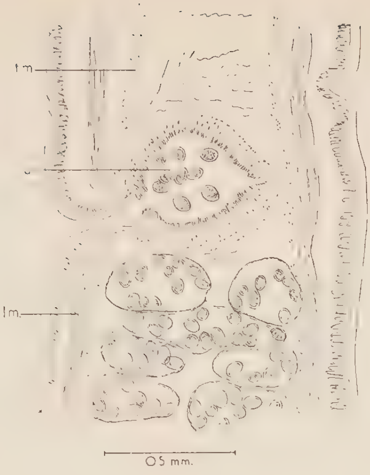

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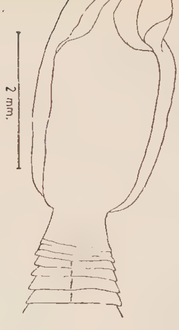

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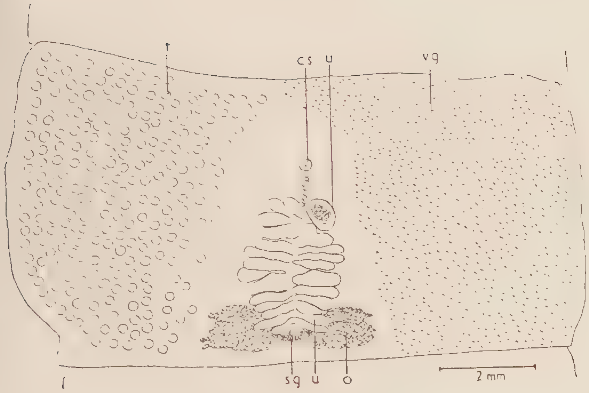

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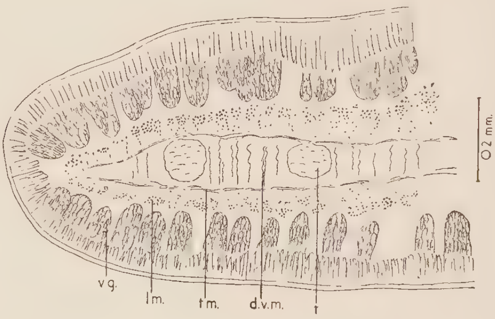

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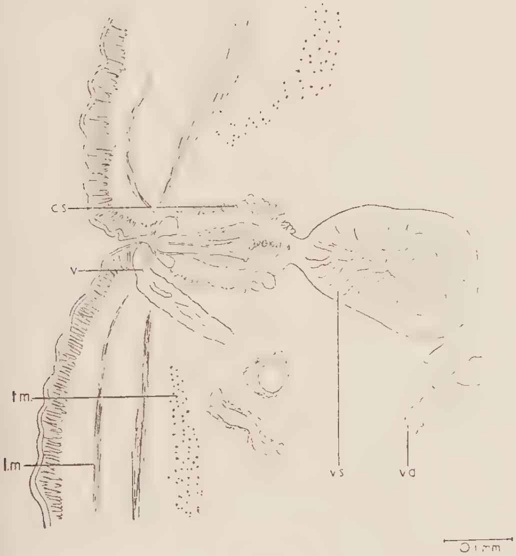

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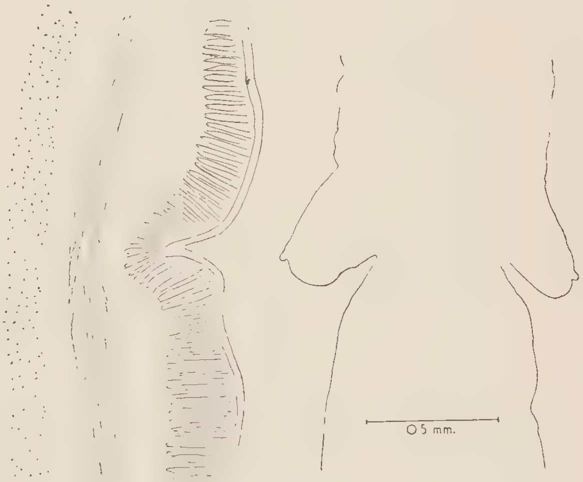

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FIGS. 37–43

Diphyllobothrium wilsoni (Shipley, 1907)

[PL. 10, FIG. 5; PL. 11, FIG. 14; PL. 16, FIGS. 44–50]

Dibothriocephalus wilsoni Shipley, 1907.
Dibothriocephalus scotti Shipley, 1907.
Diphyllobothrium scotti Meggitt, 1924.
Dibothriocephalus mobilis Leiper & Atkinson, 1915 (*nec* Rennie & Reid, 1912).

Host: Weddell seal (*Leptonychotes weddelli*) and Leopard seal (*Hydrurga leptonyx*).

Locality: Deception Island; Beascochea Bay; Debenham Islands; Melchior Archipelago; Argentine Is. (Galindez I.) and South Sandwich.

The species was found in eight Weddell seals and six Leopard seals.

The length of the body varies from about 1 cm. to 5 cm. with a maximum width of 3 mm.

The scolex is variable in size and shape, probably the result of contraction due to fixation; its length is about 825 μ and the width from 450 μ to 1 mm. The presence of glandular tissue in the scolex has been confirmed, using Ehrlich's haematoxylin and erythrosin.

The neck is very short and often impossible to distinguish, 375 μ in length and about 240 μ in width.

The first segments are shorter than wide, becoming gradually squarish, and then longer than wide. The terminal segment is usually oval or elongate-oval.

The genital rudiments occur in the first segment behind the scolex.

The cirrus-sac is 106–165 μ long and 83–99 μ high in sagittal section. It is attached in its hinder part, with numerous well-developed muscular fibres, to the dorsal wall of the segment. These structures are plainly visible in a sagittal section 10 μ thick. The contracted cirrus seems to be coiled spirally. When everted the cirrus is about 44 μ to 59 μ in length.

The vesicula seminalis is about 92 μ in length and 56 μ in width, with the walls about 20 μ thick.

The vas deferens, filled with sperm, runs dorsally and is irregularly coiled.

There are about 150 testes, 75 on each side of the segment, arranged in a single layer and very closely distributed. They are confluent in the anterior part of the segment, irregular in shape, with slightly lobed outlines. There are 8 testes on each side in the transverse and 6 to 8 in the sagittal section; their dimensions are about 132 μ by 99 μ. Histologically, as compared with other species, the testes seem to be more compact and stain more intensively with Ehrlich's haematoxylin. This may, however, be due to the number of spermatozoa in the testicular tissue absorbing more of the stain.

The uterine openings are irregularly alternating. The uterus forms an irregular spherical sac filled with eggs and surrounds the cirrus-sac on both sides.

The vagina opens close to the male genital opening in the common genital atrium.

The eggs are 50 μ by 40 μ.

The ovary is irregular in outline or kidney-shaped with more or less lobated edges. It is composed of large egg cells.

The vitelline glands, measuring 66 μ by 50 μ, are irregularly spherical and somewhat amoeboid, very numerous, and strongly developed. They form thick uninterrupted layers from segment to segment, covering all the internal organs, except the uterus.

The longitudinal musculature is not very strongly developed. It forms a coat composed of minute bundles about 17 μ thick in transverse section.

The central, medullary excretory system consists of two main stems not very easily distinguishable. The cortical excretory system possesses approximately 14 stems, fairly large in diameter, running among the vitelline glands.

It seems from a comparison of the small specimens of *D. wilsoni* and the type specimens of *D. scotti*, described by Shipley (1907), with the newly-collected material from the Leopard seal, that *D. scotti* is a synonym of *D. wilsoni*. The comparison in Table 3 of Fuhrmann's data (1920) with the figures recorded from the present material shows that there is practically no difference between the two so-called species, except in the size of the body, and it is this which seems to have misled previous authors. The small, mature specimen of *D. wilsoni* might be considered a dwarf form, caused by mass infection and consequent unfavourable living conditions. In the Leopard seal, where the infection is not so heavy, *D. wilsoni* reaches a relatively large size.

TABLE NO. 3

Comparison of D. wilsoni *and* D. scotti

	Fuhrmann (1920)		*Writer's material*
	D. wilsoni	*D. scotti*	*D. wilsoni*
Body: length	10 mm.	9 cm.	5 cm.
width	1·7 mm.	2 mm.	1·5–3 mm.
Scolex: length	850 μ	500–900 μ	825 μ–1 mm.
width	450 μ	700 μ	450 μ–1 mm.
Neck: length	?	short	375 μ
width	?	?	240 μ
Cirrus-sac: length	140 μ	150 μ	106–165 μ
width	?	?	83–99 μ
Vesicula seminalis, diameter	80 μ	80 μ	92 × 56 μ
No. of testes:			
transverse section	6–9	6	8
sagittal section	6	6–10	6–8
Eggs, diameter	60 × 36 μ	64 × 40 μ	50 × 40 μ
No. of cortical excretory vessels	14	12	14
Thickness of longitudinal muscle-layer	12 μ	14–18 μ	17 μ

2. ***GLANDICEPHALUS*** Fuhrmann 1920

Glandicephalus antarcticus (Baird, 1853)

[PL. 10, FIG. 6; PL. 11, FIG. 15; PL. 17, FIGS. 51–53]

Bothriocephalus antarcticus Baird, 1853.
Dibothrium antarcticum Diesing, 1863.
Diplogonoporus antarcticus Lühe, 1899.
Dibothriocephalus antarcticus Shipley, 1907.
Diphyllobothrium antarcticum Railliet & Henry, 1912.
Glandicephalus antarcticus Fuhrmann, 1920.

Host: Ross seal (*Ommatophoca rossi*).

PLATE 16, FIGS. 44–50

(*For list of abbreviations see Plate* 10)

Diphyllobothrium wilsoni from Weddell seal

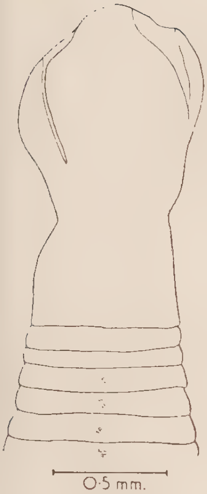
FIGS. 44–46. Scolex in different stages of contraction.

FIG. 47. Gravid segment.

FIG. 48. Terminal segment with double set of gravid genital organs.

FIG. 49. Transverse section of segment.

FIG. 50. Sagittal section of segment.



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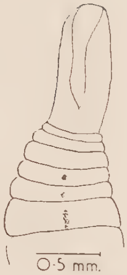

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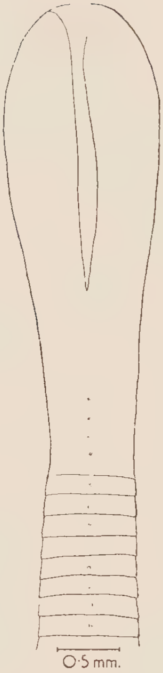

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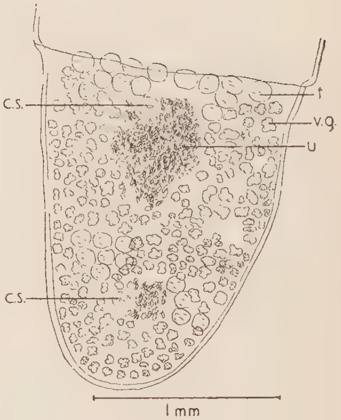

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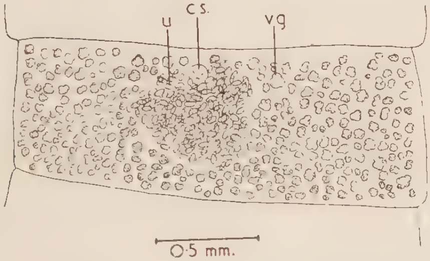

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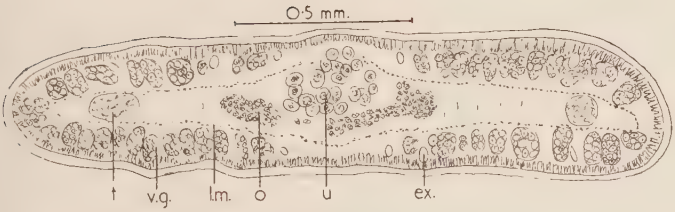

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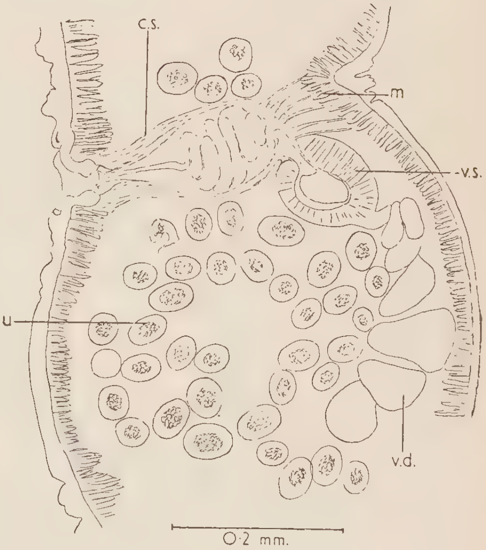

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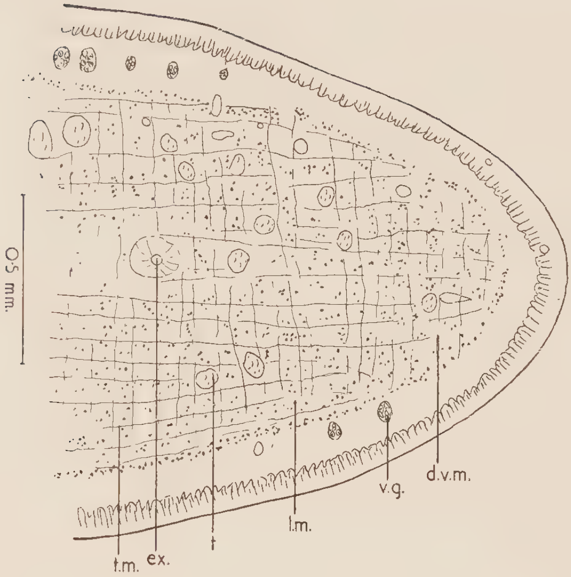
Figs. 44–50

PLATE 17, FIGS. 51–53

(*For list of abbreviations see Plate* 10)

Glandicephalus antarcticus from Ross seal

Fig. 51. Scolex.
Fig. 52. Sagittal section of several segments.
Fig. 53. Transverse section of segment.



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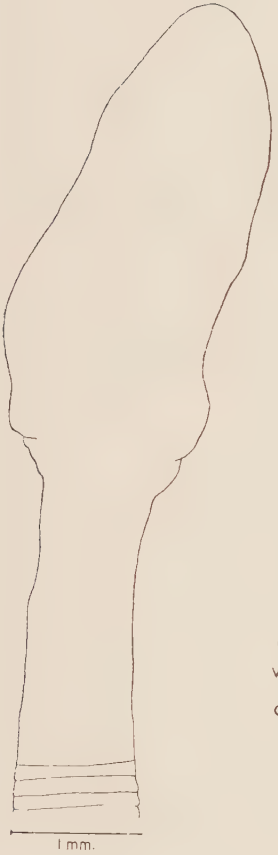

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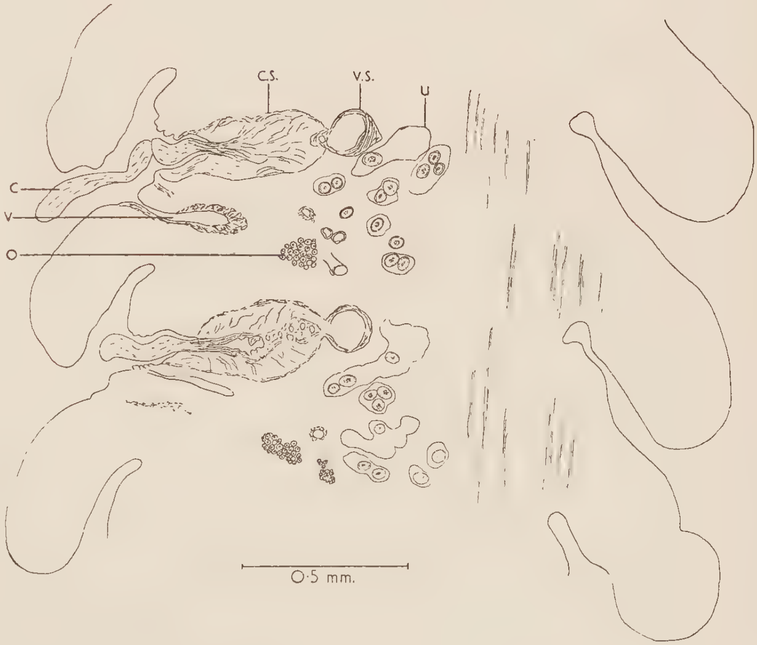

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Figs. 51–53

This species, described by Baird (1853) and re-described by Fuhrmann (1920), was collected by the Ross's Antarctic Expedition. To give a complete picture of the Pseudophyllidean Cestodes occurring in Antarctic seals, however, the type-specimens have been re-described to show their generic relationship with *Glandicephalus perfoliatus*.

The specimens re-examined were about 10 cm. in length and 7 mm. in width. The strobila is markedly imbricate.

The scolex, 3 mm. in length and 2 mm. in width, is provided with protuberances as depicted by Baird, though these are not distinct in all specimens. No glandular structure was discovered in sagittal serial sections stained with Ehrlich's haematoxylin.

The neck is about 2·35 mm. long and 750 μ in width.

The cirrus-sac, in sagittal section, measured about 462 μ in length and 231 μ in height.

The vesicula seminalis is about 132 μ by 155 μ, with walls about 10 μ thick.

The testes are scattered in the medullary parenchyma and among the longitudinal musculature. They are arranged in irregular layers.

The eggs are 43–50 μ by 33 μ and the vitelline glands are about 40 μ by 50 μ.

The muscular system, as described and depicted by Fuhrmann (1920), is almost identical with that of *G. perfoliatus*. The longitudinal muscular coat is about 450 μ thick.

There are about 30 excretory vessels, counted in the transverse section of the cortical parenchyma.

Glandicephalus perfoliatus (Railliet & Henry, 1912) n. comb.

[PL. 10, FIG. 7; PL. 11, FIG. 16; PL. 18, FIGS. 54–59]

Diphyllobothrium perfoliatum Railliet & Henry, 1912.
Dibothriocephalus perfoliatus Fuhrmann, 1920.
Diphyllobothrium clavatum Railliet & Henry, 1912.
Diphyllobothrium rufum Leiper & Atkinson, 1914.

Host: Weddell seal (*Leptonychotes weddelli*).

Locality: Debenham Islands; Stella Creek, Deception Island; Argentine Is. (Galindez I. and Winter I.); Beascochea Bay, Graham Land (Hut Cove, Hope Bay); and Palmer Archipelago (Port Lockroy, Wiencke Island).

This species was collected from thirteen Weddell seals. It occurs usually as a mass infection, mainly in the bile-duct, overhanging into the gut. The specimens examined were at different stages of maturity from 4 mm. to 20 cm. in length. The average length of the body ranges from 12 to 14 cm., and the minimum width is 7 mm.

The strobila is differentiated into two distinct parts: the anterior, ivory white, amounting to about one-third of the total length, and the posterior, yellowish, increasing in width and tapering slightly at a small distance from the posterior end of the body. This differentiation of the strobila has not been observed in specimens of 4 cm. or 5 cm. in length, in which the outline of the body is oval with a well-defined scolex. The surface of the strobila bears, a small distance behind the neck, characteristic strongly developed imbrications formed by the excessive development of the cortical part of the segment.

The scolex is about 3·5 mm. in length, measured in formalin specimens, and 2 mm. in width. No glandular structure has been discovered in longitudinal sections of the organ.

The neck is distinct and ranges from 2·5 mm. to 3 mm. in length and 1 mm. in width.

The segments are very short. The length of a fully gravid proglottid, measured in a sagittal serial section, is about 400 μ. The terminal segment is small and bell-shaped, with a cone at the terminal part of its longitudinal axis. It contains normal genital organs and produces eggs. This peculiar shape of the segment may be the result of fixation.

The genital openings are irregularly alternating and situated on the anterior surface of the imbrications.

The length of the cirrus-sac, measured in a sagittal section, is about 264 μ, and its width 188 μ.

The pear-shaped vesicula seminalis is 148 μ long and 132 μ wide in sagittal section; its walls are about 20 μ thick.

There are about 100 testes in the fully gravid proglottid. They are more or less distributed in a single layer, which is more readily distinguishable in the lateral part of the segment. Near the centre, close to the uterine coils, the testes are arranged in irregular clumps. In transverse section there are about 14 testes on each side, and in the sagittal plane from 3 to 6; they measure 116–172 μ by 73–93 μ.

The vagina opens immediately behind the male pore, slightly obliquely.

The uterine openings are irregularly alternate on the left or right side of cirrus-sac, and the uterus forms an irregular sac with indistinct coils, filled with eggs. These, some of them provided with a boss, are about 60–66 μ by 50 μ.

The ovary comprises two small wings tapering towards the lateral edge of the segment.

The vitelline glands, distributed mainly in the anterior region of the imbrications of the segment, are very irregular in shape and size and measure about 70 μ by 40 μ.

The longitudinal musculature of this species is very unusual and almost identical in structure with that of *G. antarcticus* (Baird). Together with the transverse and dorso-ventral muscular system, it is distributed throughout almost the whole medullary part of the segment. The single bundles of the longitudinal muscular system are separated by the fibres of the dorso-ventral and transverse musculature. Examined in transverse section the two lateral systems form a kind of square which encloses, at its centre, the fibres of the longitudinal muscles. The boundary between the cortical and medullary parenchyma, so characteristic of, and fairly easily distinguishable in, most other species of Pseudophyllidean Cestodes, is not very distinct in *G. perfoliatus*, because of the network formed by the transverse and dorso-ventral musculature, through the meshes of which run the fibres of the longitudinal muscles. In the near vicinity of the testes, or of the excretory vessels, the muscular system is more diffuse.

The central excretory system in the medullary parenchyma is composed of 2 vessels, which run an undulating course through the length of the body and are about 17 μ in diameter. The cortical excretory system seems to be composed of 16 vessels.

PLATE 18, FIGS. 54–59

(*For list of abbreviations see Plate* 10)

Glandicephalus perfoliatus from Weddell seal

FIG. 54. Young immature specimen.

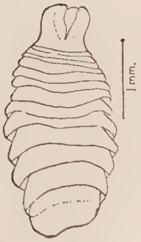
FIG. 55. Young specimen showing differentiation of strobila.

FIG. 56. Portion of strobila showing internal structure, after removal of part of cortical parenchyma.

FIG. 57. Sagittal section of segments with male and female openings.

FIG. 58. Sagittal section of two posterior segments.

FIG. 59. Transverse section of segment, with vitellaria in portion of imbrication.



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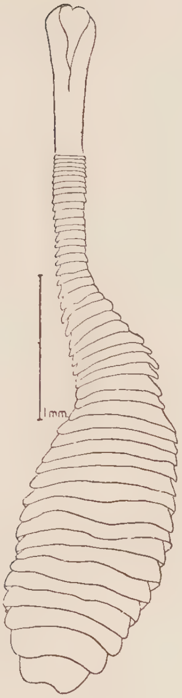

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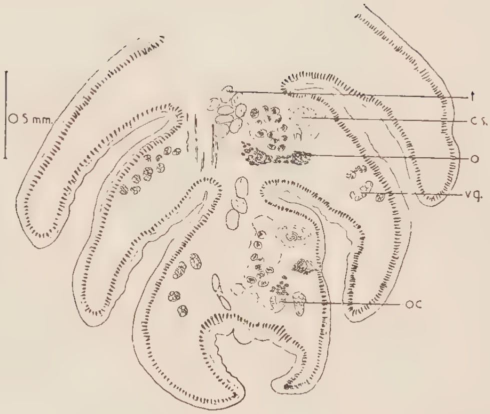

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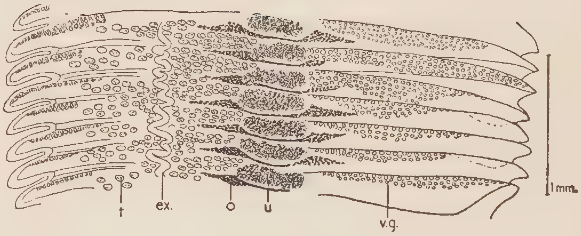

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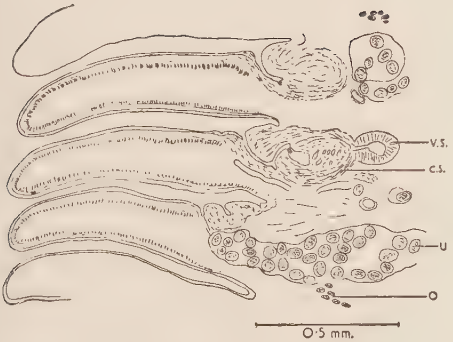

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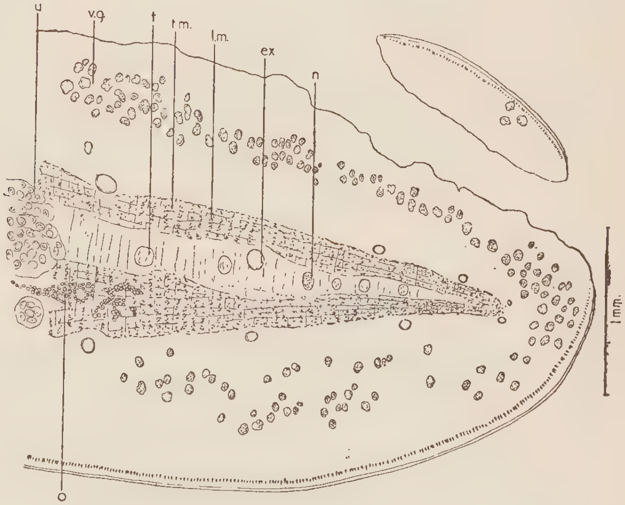

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Figs. 54–59

The two main nerves, 66 μ by 44 μ in transverse section, are situated outside the medullary excretory system.

Comparison of this material with the type specimens of *Glandicephalus antarcticus* (Baird) reveals that, although there is no doubt that there are two distinct species, these have features in common that appear to warrant their being grouped together in a single genus distinct from *Diphyllobothrium*; the name *Glandicephalus* Fuhrmann (1920) is available. It is true that this name was coined by Fuhrmann in consequence of his discovery of glandular tissue in the scolex of *antarcticus* and that no such tissue has been found in the scolex of *perfoliatus*; but this character is not at all diagnostic of *Glandicephalus* and occurs in several species of *Diphyllobothrium*, e.g. *D. lashleyi*, *D. mobile*, and *D. quadratum*. Features common to both *antarcticus* and *perfoliatus*, but not found in any true *Diphyllobothrium*, are as follows: imbrication of the segments (less well developed in the first species); presence of a well-separated neck, and the arrangement of the musculature. In both species the transverse and dorso-ventral muscles form a kind of network spread in the medullary parenchyma, enclosing in the 'meshes' the fibres of the longitudinal muscles. Moreover, the vitelline glands are situated in the anterior region of the imbrications of both species. Finally, they seem to show a host specificity: *G. antarcticus* for *Ommatophoca* and *G. perfoliatus* for *Leptonychotes weddelli*.

Leiper & Atkinson (1914) describe another species from the Weddell seal, namely, *Diphyllobothrium rufum*. Johnston (1937), who examined immature specimens which he thought to be *D. rufum*, was apparently inclined to believe that the species was probably a 'precocious form' of *G. perfoliatus*. Comparison of the type-specimens of *D. rufum* with *G. perfoliatus* reveals that the only differences are in the shorter neck and the presence of a 'notch' in the posterior margin of some of the segments. The neck of *D. rufum*, measured in sagittal section, is over 1 mm. in length. To judge from the published descriptions there would seem to be a difference in egg size also, for Leiper & Atkinson report the eggs of *D. rufum* to be 25 μ in diameter. This, however, appears to be a slip; in the type specimens their dimensions are 59–66 μ by 43–46 μ, which is identical with the size of the eggs in *G. perfoliatus*. Further, there are no differences in the structure of the genital apparatus or of the musculature. *Diphyllobothrium rufum* seems, therefore, to be a synonym of *Glandicephalus perfoliatus*.

3. ***BAYLISIA*** gen. nov.

Diagnosis: Large Cestodes in which the anterior part of the body is cylindrically modified. Scolex with cup-shaped bothria. Normal segmentation not distinct; the body bears pseudosegmentation not corresponding to the individual sets of genital organs.

Genital organs and their openings situated ventrally on both sides of the segment in double sets, regularly alternate in relation to the main axis of the body.

Testes arranged in a single layer. Ovary ramified. Longitudinal muscles forming a thick coat. Excretory system situated in the cortical parenchyma.

Type species: *Baylisia baylisi* sp. nov.

Type host: Crabeater seal (*Lobodon carcinophagus*).

Baylisia baylisi sp. nov.

[Pl. 10, fig. 8; Pl. 11, fig. 17; Pl. 19, figs. 60–68]

Host: Crabeater seal (*Lobodon carcinophagus*).
Locality: Deception Island; Debenham Islands.

This parasite has been found in two Crabeater seals. There were two complete worms, one 35 cm. in length and 1 cm. in width and a second 126 cm. by about 8 mm., together with some fragments of strobila, varying from 15 cm. to 63 cm. in length and from 11 mm. to 15 mm. in width.

The colour in formalin is ivory-white in the anterior part of the body, becoming brownish-grey in the posterior segments. The ivory-white part of the strobila, about 2 cm. in length, is more or less cylindrical.

There are two double furrows running laterally along the body. The central part of the strobila is convex along the main axis, marking the position of the uterus.

The scolex has two cup-shaped bothria, and measures, in the specimen mounted in Canada, balsam about 900 μ long and 1·3 mm. broad.

A neck seems not to be developed since segmentation starts immediately behind the scolex.

The segmentation is very distinct, but apparently does not divide the body into single genital complexes, as happens in other tapeworms. The 'segments' are 2 cm. long and about 1·5 cm. in width, the terminal one being oval.

The genital openings are situated ventrally on a segment in the longitudinal furrows, alternately left and right. There are about 30–40 double genital sets in one 'segment', which alternate in relation to the main axis of the body, being arranged in 'zigzag', in contrast to *Diplogonoporus*, where they occur as two genital sets in the same transverse plane. In *Baylisia baylisi* one set of the genital organs only may be seen in transverse section.

The cirrus-sac measures 750 μ long and 180 μ high in sagittal section. An irregularly coiled ductus ejaculatorius is situated inside the cirrus-sac. A cirrus has not been observed.

The vesicula seminalis is situated slightly laterally but internally to the cirrus-sac, and is 198 μ long and 99 μ wide in sagittal section; its walls are about 33 μ to 50 μ thick. The internal surface of the walls seems to have a villous structure.

Beside the normally developed cirrus-sac mentioned above, one abnormality has been noted. Two cirrus-sacs were joined together, with a common opening, but each with a separate vesicula seminalis (Pl. 20, fig. 65).

In each segment there are about 36 testes arranged in a single layer and flattened antero-posteriorly. The number of testes in transverse section amounts to about 18 on each side, and there is 1 testis in sagittal section. The testes measure 165 μ in diameter in transverse section and 40 μ in the sagittal plane. They are elongate-oval, 116 μ by 40 μ in horizontal section, with the longer axis transverse to the main line of the segment.

The vagina opens into the genital atrium with the male opening and runs ventrally, but is transverse to the terminal part of the uterus.

PLATE 19, FIGS. 60–68

(*For list of abbreviations see Plate* 10)

Baylisia baylisi from Crabeater seal

FIG. 60. Scolex.

FIG. 61. Sagittal section of fused cirrus-sac, with common genital duct and opening.

FIG. 62. Transverse section of part of male and female genital apparatus.

FIG. 63. Transverse section of segment, showing structure of ovary and genital ducts.

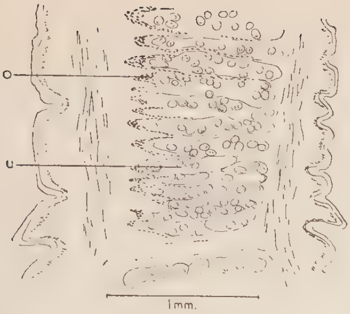
FIG. 64. Sagittal section of part of segment, showing arrangement of ovaries and uterine coils

FIG. 65. Transverse section of male and female ducts (enlarged).

FIG. 66. Transverse section of segment.

FIG. 67. Sagittal section of segment, showing male copulatory organs.

FIG. 68. Horizontal section of part of strobila, showing arrangement of genital organs.



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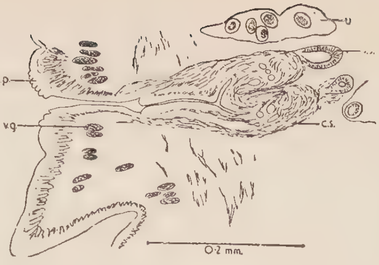

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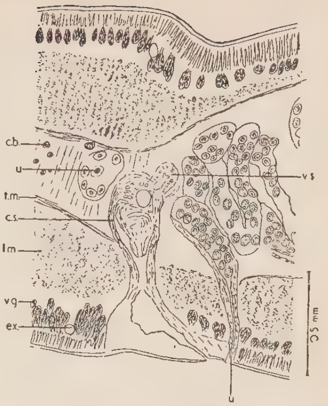

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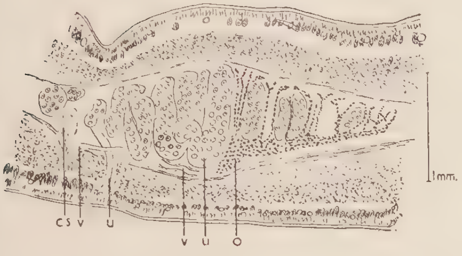

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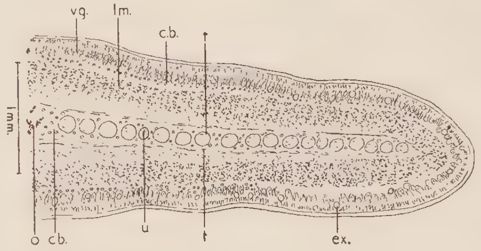

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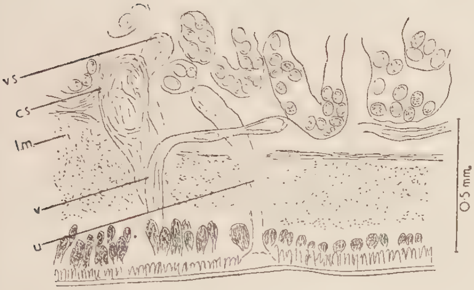

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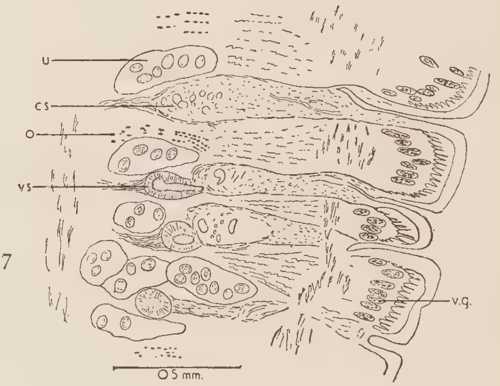

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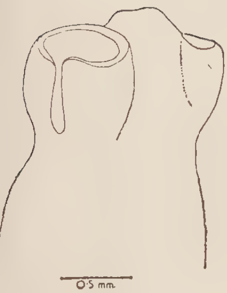

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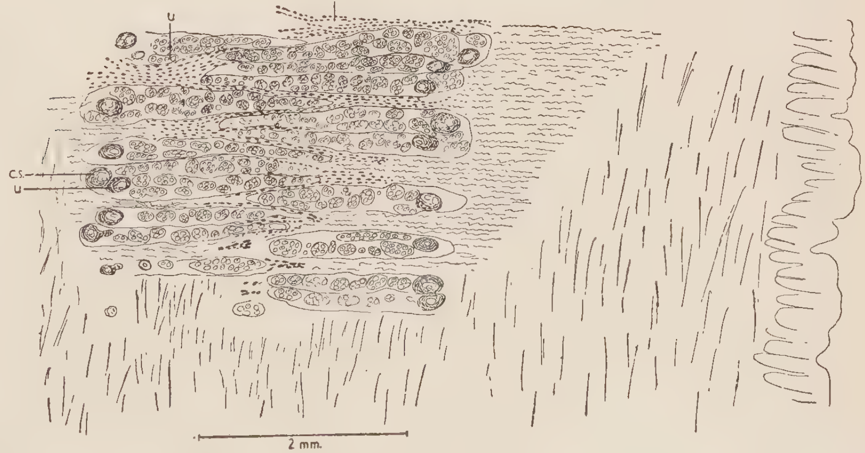

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FIGS. 60–68

The uterine openings on both sides are situated nearer the median line than the genital openings and lie posteriorly and obliquely to the cirrus-sac. The uterus itself comprises a few horizontal coils in the central part of the segment.

The ovary is very characteristic and is composed of one solid compact central part, giving off a system of branches and ramifications among the uterine coils; in sagittal section it is V-shaped.

The eggs are 66 μ by 46 μ.

The musculature is very well developed. The longitudinal muscles form, in transverse section, a continuous coat about 450 μ thick, composed of numerous bundles. The transverse muscles are also well developed but the dorso-ventral musculature is much weaker.

The excretory system seems to occur only in the cortical parenchyma, and is composed of about 76 vessels, visible in transverse section. Their transverse diameters differ considerably. This cortical excretory system is situated near the surface of the segment and runs among the vitelline glands.

The vitelline glands, 43 μ by 20 μ, are composed of tiny cells and form a continuous layer, interrupted by the excretory system. They are more or less irregularly elongate in sagittal section, and elongate-oval in the horizontal plane.

'Calcareous' bodies are very numerous, 17 μ by 26 μ in diameter, and occur in the cortical and medullary parenchyma. They have also been noticed among the longitudinal muscles.

4. ***BAYLISIELLA*** gen. nov.

Diagnosis: Pseudophyllidean Cestodes with the scolex bearing two strongly developed bothria, modified in the anterior part in a foliaceous lamella. The thick strobila, composed of very short and broad segments, is tapering posteriorly. The testes, arranged in two or three layers in the medullary parenchyma, have a tendency to ascend dorsally in relation to the uterus. The longitudinal muscles form, in transverse section, club-shaped or elongately oval bundles, some of them collected in pyramids, separated by the excretory vessels. Excretory system occurs in the cortical parenchyma.

Type species: *Baylisiella tecta* (Linstow).

Type host: Elephant seal (*Macrorhinus leoninus*).

Baylisiella tecta (Linstow, 1892)

[PL. 10, FIG. 9; PL. 11, FIG. 18; PL. 20, FIGS. 69–72]

Bothriocephalus tectus Linstow, 1892.
Dibothriocephalus tectus Zschokke, 1903.
Diphyllobothrium tectum Meggitt, 1924.
Cordicephalus tectus Wardle, McLeod, & Stewart, 1947.

Host: Elephant seal (*Macrorhinus leoninus*).
Locality: Bay of Isles, South Georgia.

This species was found in two Elephant seals; there were three entire worms in one host and two in the other, one specimen being headless.

The thick belt-shaped strobila, composed of very short indistinct segments, is 32 cm. in length and 2 cm. in width.

The previous descriptions of Linstow (1892) and Fuhrmann (1920) were based on headless specimens.

The scolex, not previously described, is deeply embedded in the intestinal tissue and very characteristic in shape. It possesses two powerful bothria and a complicated lamellar structure of their upper part, which recalls the scolex of *Pyramicocephalus* Monticelli 1890. The 'cauliflower' lamellar structure seems to give rise to two lateral lamellar flaps and there is a similar differentiation on the top of the scolex. The length of the scolex is 8 mm. and the width 5 mm., and the transverse diameter across the 'flap' is 12 mm.

The neck seems to be very short or not-existent.

The segments are very short, about 165 μ–200 μ in length.

The genital pores are situated in a common recess, provided with numerous papillae.

The cirrus-sac, measured in sagittal section, is about 450 μ in length and 150 μ in height.

The vesicula seminalis, situated in the same axis as the cirrus-sac, is 195 μ in length and 180 μ in width; its walls are about 30 μ thick.

The vas deferens runs dorsally in numerous coils.

The testes are distributed in 2 or 3 layers, some of them ascending almost dorsally to the uterus and close to it. There are about 45 testes on each side in transverse, and 2 or 3 in sagittal, sections. They measure about 136 μ by 86 μ.

The uterine openings are situated a little below the cirrus-sac on the right side. The uterus comprises a few irregular transverse coils.

The vagina opens in the vicinity of the cirrus-sac on its right side.

The ovary is bilobed and elongate.

The eggs with 3 μ thick shells, measure 59–66 μ by 46 μ and are thickened opposite to the operculum.

The vitelline glands, 66 μ by 26 μ, and arranged in a very thick layer, are very numerous, spherical or oval in transverse section. They form a compact mass of glands in the cortical parenchyma.

The excretory system seems to occur in the cortical part of the segment. It is very strongly developed and runs through the longitudinal muscular system with numerous transverse anastomoses. In transverse section about 108 excretory canals have been counted.

The musculature is exceedingly well developed. The longitudinal muscles are collected in large irregular bundles, which, in transverse section, appear club-shaped or elongate-oval. The bundles are often separated into distinct groups between which run excretory canals and dorso-ventral muscle-fibres. The thickness of the longitudinal muscular coat is about 555 μ. There is also a layer of longitudinal muscles situated in the subcuticular region of the segment, externally to the vitelline glands. This additional layer is composed of scattered, rather thick, individual fibres or very small bundles of fibres. The transverse muscles are also very strongly developed.

This species represents a new genus, *Baylisiella*, distinguished from *Bothriocephalus*

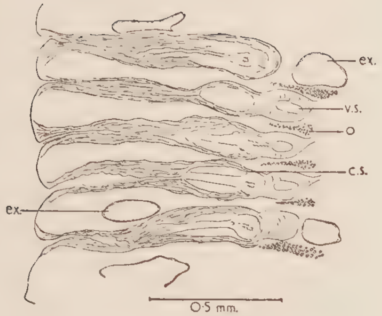
PLATE 20, FIGS. 69–72

(*For list of abbreviations see Plate* 10)

Baylisiella tecta from Elephant seal

FIG. 69. Transverse section of segment.
FIG. 70. Transverse section of male apparatus.
FIG. 71. Sagittal section of segment.
FIG. 72. Scolex.

PLATE 20



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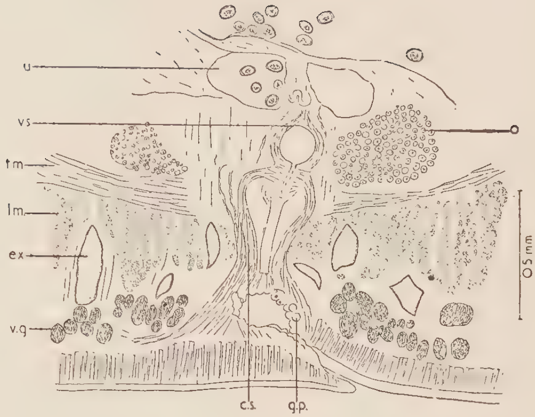

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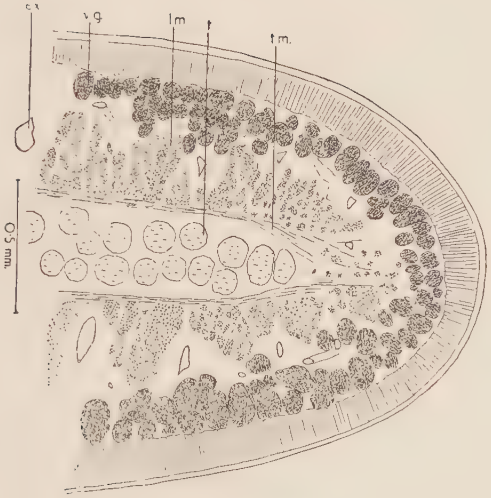

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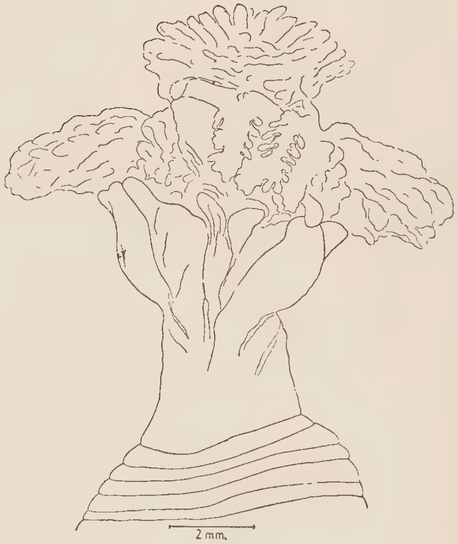

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FIGS. 69–72

and *Diphyllobothrium* by characteristic differences in the structure of the scolex, in the development of the muscles, and in the distribution of the testes.

? ***Diphyllobothrium*** larvae

[PL. 21, FIGS. 74–75]

Host: Weddell seal (*Leptonychotes weddelli*): Leopard seal (*Hydrurga leptonyx*).
Locality: Melchior Archipelago; Debenham Islands; Cooper Bay, South Georgia.

Beside the adult forms enumerated in this paper, juvenile stages have also been discovered in five Weddell seals and in one Leopard seal. The infection bears in some cases a mass character. The identification of these juvenile forms was not possible, because of a complete lack of morphological features. They belong probably to one of the species dealt with here, most likely to *Diphyllobothrium wilsoni* or *D. mobile*.

Based on differences in the scolex, two types of larvae might be distinguished: one with a kind of papillary modification occurring at the edge of the bothria, and another with the typical scolex of *Diphyllobothrium* but with the bothria smooth.

The maximum length of the body of the first type, from the Weddell seal, is about 3 mm. long and about 1 mm. in width, and the second, from the Leopard seal, is about 1·2 mm. in length and 195 μ in width.

? ***Diphyllobothrium*** sp. (larva)

[PL. 21, FIG. 73]

Host: Crabeater seal (*Lobodon carcinophagus*).
Locality: South Sandwich.

This juvenile stage was collected by the *Discovery* on 21 March 1928 from the intestine of a Crabeater seal.

The total length of the body is 7 mm. and the width 480 μ.

The scolex is well separated from the rest of the body and is heart-shaped, tapering anteriorly. Its length is 675 μ and its width 480 μ.

The bothria are well developed.

The unsegmented body has neither genital organs nor their rudiments, making identification impossible.

OCCURRENCE OF THE PARASITE AND ITS RELATIONSHIP TO THE HOST

As already stated, there are nine species of Pseudophyllidean Cestodes known to occur in the Antarctic seals. An analysis of the parasites and their hosts is shown in Table No. 4.

Our knowledge of these parasites is very limited and the present material is merely the tenth collection of this kind. Nevertheless, certain speculations may be justifiably made on the occurrence and the host specificity of these parasites, as well as on their

TABLE No. 4

Composition of Pseudophyllidean Cestodes in the present material

Diphyllobothrium lashleyi (Leiper & Atkinson, 1914)	*Leptonychotes weddelli*
D. mobile (Rennie & Reid, 1912)	,, ,,
D. quadratum (Linstow, 1892)	*Hydrurga leptonyx*
D. scoticum (Rennie & Reid, 1912) . . .	,, ,,
? *D. sp.* (larva)	*Lobodon carcinophagus*
D. wilsoni (Shipley, 1907)	*Leptonychotes weddelli, Hydrurga leptonyx*
Glandicephalus antarcticus (Baird, 1853) . .	*Ommatophoca rossi*
G. perfoliatus (Railliet & Henry, 1912) . .	*Leptonychotes weddelli*
Baylisia baylisi gen. nov., spec. nov. . . .	*Lobodon carcinophagus*
Baylisiella tecta (Linstow, 1892) gen. nov. . .	*Macrorhinus leoninus*

host-relationship. It may be presumed that *Glandicephalus perfoliatus* and *Diphyllobothrium lashleyi* are specific to the Weddell seal, *G. antarcticus* to the Ross seal, and *D. quadratum* and *D. scoticum*[1] to the Leopard seal. The newly-described *Baylisia baylisi* is the first identified Cestode from the Crabeater seal, although unidentified tapeworms have been reported from this host by Railliet & Henry (1912). *Baylisiella tecta* seems to be closely associated with the Elephant seal. Linstow (in Shipley, 1902) identified some Cestodes collected from the Ross seal as belonging to this species, but this identification requires confirmation. The two next species, *Diphyllobothrium mobile* and *D. wilsoni*, are less selective in their hosts, the first occurring in the Weddell and Ross seals, the second in the Leopard and Weddell seals. According to information supplied by Dr. G. C. L. Bertram, who collected the Graham Land material, the most frequently and heavily infested species are the Weddell seal, the Leopard seal, and the Elephant seal. In the Crabeater seal infestation with tapeworms very seldom occurs and the present record is virtually the first.

It is obvious that the nature of the food has an enormous influence on the kind and number of parasites. The Weddell seal eats fish and cephalopods. The food of the Leopard seal is composed of penguins and fish. The food of the Crabeater seal consists of Crustacea, mainly Euphausiids.

These Cestodes occur in specific parts of the gut of the host. *Glandicephalus perfoliatus* infests mainly the bile-duct, overhanging into the lower part of the intestine. It occurs very often as a mass infection, choking the lumen of the bile-duct. *Diphyllobothrium lashleyi*, *D. mobile*, *D. quadratum*, *D. scoticum*, and *D. wilsoni* infest the duodenal part of the gut and *Baylisia baylisi* and *Baylisiella tecta* occur in the rectum. Except for these two and *Diphyllobothrium scoticum*, the rest of the species occur very often as a mass infestation occupying almost all the free surface of the gut.

D. scoticum does not occur in such numbers as the others but makes up for it in the size of the individuals. It is the largest Cestode recorded from the Antarctic seals. *Baylisiella tecta* also is fairly large and is not numerous in the gut.

Diphyllobothrium wilsoni and *D. mobile* have been considered by previous authors as dwarfs, and the smallest species of *Diphyllobothrium*, *D. wilsoni*, is very small, reaching in mass infestation no more than 10 mm. in length. On the other hand, specimens collected from the less heavily infested Leopard seals reach from 5 to 9 cm.

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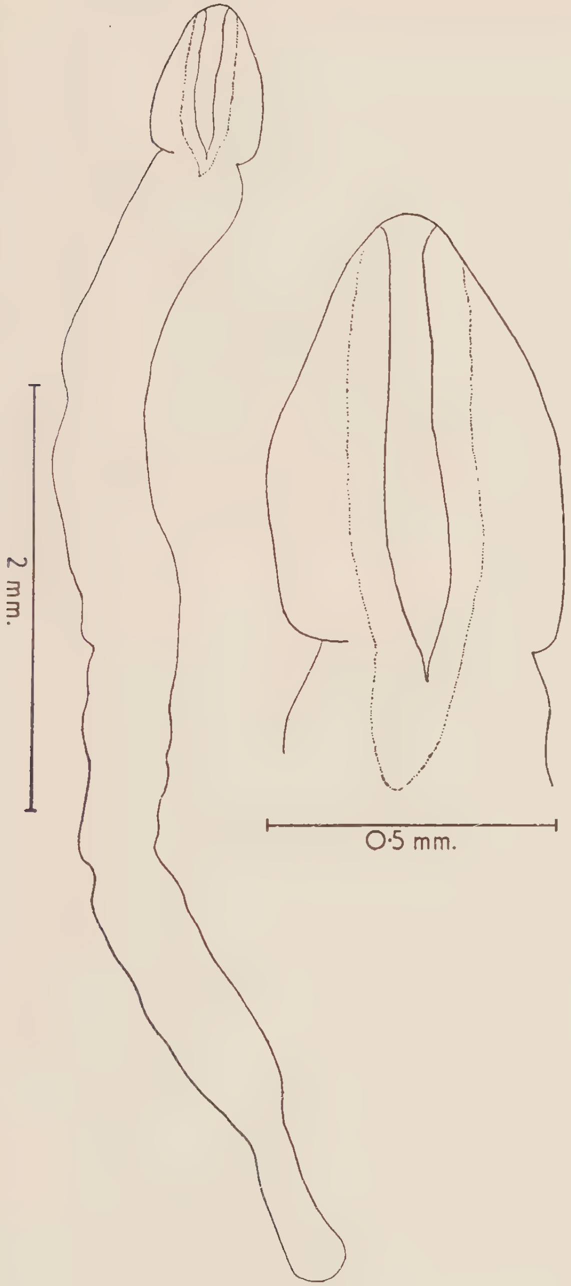
[1] See footnote on p 137.

PLATE 21, FIGS. 73–75

FIG. 73. ? *Diphyllobothrium* sp. from Crabeater seal.

FIGS. 74–75. Two types of larvae from Weddell seal.



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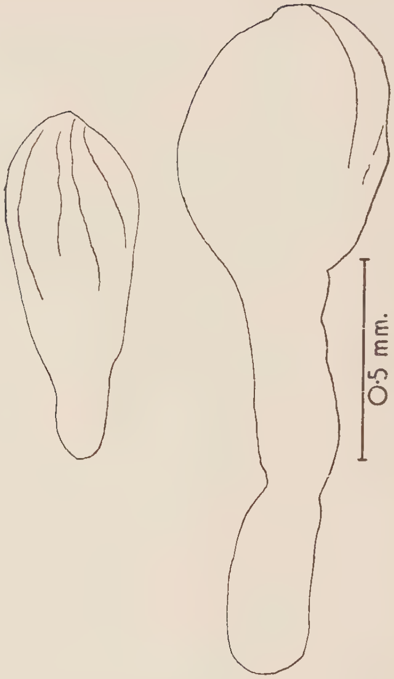
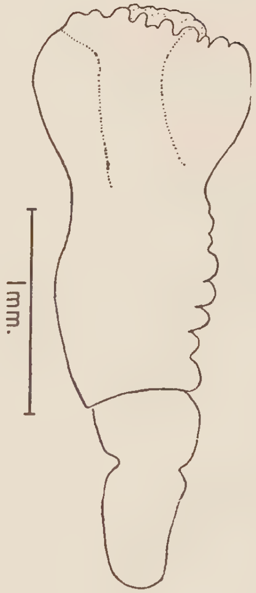


75



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Figs. 73–75

in length. The larger specimens were considered by Shipley (1907) to be a separate species, *D. scotti*. It is quite probable that further investigation of the Cestodes of Antarctic seals will prove that the small size of *D. mobile* is also caused by the living conditions in mass-infected hosts.

Where a mass infestation occurs one species of Cestode only is invariably present. Usually in the moderately infested hosts the Cestodes may represent more than one species. *Glandicephalus perfoliatus* was recorded in the same host together with *Diphyllobothrium lashleyi*, *D. mobile*, and *D. wilsoni*. The same has been shown for the occurrence of *D. scoticum* with *D. quadratum* and *D. wilsoni* in the same gut.

No pathological changes of the gut have been observed, except in the rectum of the Elephant seal, where *Baylisiella tecta* provokes large nodules, about 3 cm. in diameter. This is caused by the scolex being very deeply embedded in the intestinal wall. Judging from the mass occurrence of parasites in the gut of seals, there must be a high degree of immunity on the part of the host against toxic factors provoked by the parasite.

It seems from the literature that the Pseudophyllidean Cestodes found in the Antarctic seals do not occur in any other species of Pinnipeds.

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